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BIOPHYSICAL RESOURCES OF THE EAST KOOTENAY AREA : VEGETATION

VOLUME 1

E.C. Lea

SURVEYS AND RESOURCE MAPPING BRANCH

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ABSTRACT

The vegetation, its successional stages and its relationship with climate, soils and other landscape characteristics was studied as a part of a biophysical reconnaissance inventory of the southern Rocky Mountain Trench and the adjacent Rocky Mountains within British Columbia. The vegetation was sampled in over 1000 releves. For all releves information on soils, terrain and topography was recorded. For 80 of these releves soils were analyzed in detail in the laboratory.

The vegetation was classified for Forest Regions, Sections, Zones, Subzones and Vegetation Types. The study area is located mainly within the Dry Interior Region and includes part of the Interior Wet Belt Region. The Dry Interior Region is represented by the Cranbrook Section and the Radium Section. For the study area 5 Forest Zones and 11 subzones were recognized. These categories and ecological landscape units are mapped and their significance for planning is discussed.

One hundred and thirty-eight vegetation types, climax and seral communities, are described. The function of soils, terrain, local climate and other landscape characteristics in the ecosystems are discussed. The role of each vegetation type in succession in discussed. Resource values and constraints to use are determined for each type.

PREFACE

This report is one of a series of Assessment and Planning Division (APD)[1] bulletins that describe and analyze the biophysical resources of the East Kootenay area. Individual bulletins focus on terrain, soils, climate, vegetation, wildlife, aquatics, and outdoor recreation, but are closely interrelated and rely on cross-referencing rather than duplication of material. A set of base data maps at a scale of 1:50 000 is also available for each discipline.

The East Kootenay study was initiated in 1975 in response to increasing pressure on land resources and the development of land-use conflicts. Forestry, mining, ranching, farming and tourism are all major contributors to the economic well being of the region. General population growth and maintenance of these industries requires that land be allocated for urban and industrial expansion and transportation corridors, and yet at the same time, areas be preserved for wildlife and recreational purposes.

The data, analyses, and interpretations that are contained within the East Kootenay bulletin and map series will assist in the development and implementation of a rational resource management policy. In addition, information is presented here that will increase systematic knowledge of the physical and biological components of land and water systems.

It is anticipated that careful utilization of this data base will ultimately aid the maintenance of a high quality environment in this part of British Columbia.

[1]These reports are now called Ministry of Environment Technical Reports. In the report, reference has been made to the Terrestrial Studies Branch, British Columbia Ministry of Environment. This branch is now called the Surveys and Resource Mapping Branch. Maps and reports for this study are available from Maps B.C., Surveys and Resource Mapping Branch, Parliament Buildings, Victoria, British Columbia, V8V 1X5; (604) 387 - 1441. This has changed from what is stated in Appendix B.

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Appreciation goes to the editorial committee which has included Bob Louie, Larry Lacelle and Barb Mordaunt of the Terrestrial Studies Branch (Ministry of Environment), John Dick of the Planning Branch (Ministry of Environment), John Errington of the Ministry of Energy, Mines and Petroleum Resources, and Greg Utzig of the Research Branch (Ministry of Forests). Ron Muir (Terrestrial Studies Branch) provided valuable report presentation advice. Special appreciation goes to Jim van Barneveld (Terrestrial Studies Branch) who acted as editorial chairman and who provided support and direction throughout the project.

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2. Regional Vegetation (Forest Zonation discussion)
3. Broad Climate - Vegetation Relationships
4. Successional Trends of the Vegetation

Volume Two: Interpretations

1. Interpretation of Vegetation Types for Various Resource Uses
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CHAPTER ONE

INTRODUCTION

1.1 OBJECTIVES

The objectives of the vegetation study of the East Kootenay are:

a. to develop a classification of Forest Zonation and to map Forest Regions, Zones and Subzones;

b. to classify vegetation to detailed vegetation types;

c. to determine the distribution of vegetation and its relationship to climate, terrain, soils, topography, nutrient cycling and moisture availability;

d. to determine successional trends of the vegetation and their relationship to environmental factors, and

e. to provide data and interpretations for resource use and planning.

1.2 LOCATION OF STUDY AREA

The East Kootenay study area covers the British Columbia portions of the National Topographic Series sheets 82G, 82J and 82O (Figure 1.1). This area extends northward from 49° N, at the International Boundary, to 51°07' near Vermillion Pass on the continental divide and it extends eastwards from 116° W to the British Columbia - Alberta boundary, along the continental divide.

1.3 METHODS

From 1974 to 1977 over 1000 vegetation plots were selected, each chosen to be representative of a site of homogenous vegetation and uniformity in apparent soil and other physical characteristics. The data were recorded using a standard data form (Vegetation Functional Subcommittee, 1976). Information gathered in 1968 (Runka, 1969) was included in the analysis. Climax and seral vegetation was sampled. The plot dimensions used in sampling were variable, but generally approximated one tenth of a hectare although releves of high elevation communities were usually smaller while for grassland areas they were frequently larger.

The vegetation data was computer processed by dissimilarity analysis (Coenos 1, Ceska, 1975;

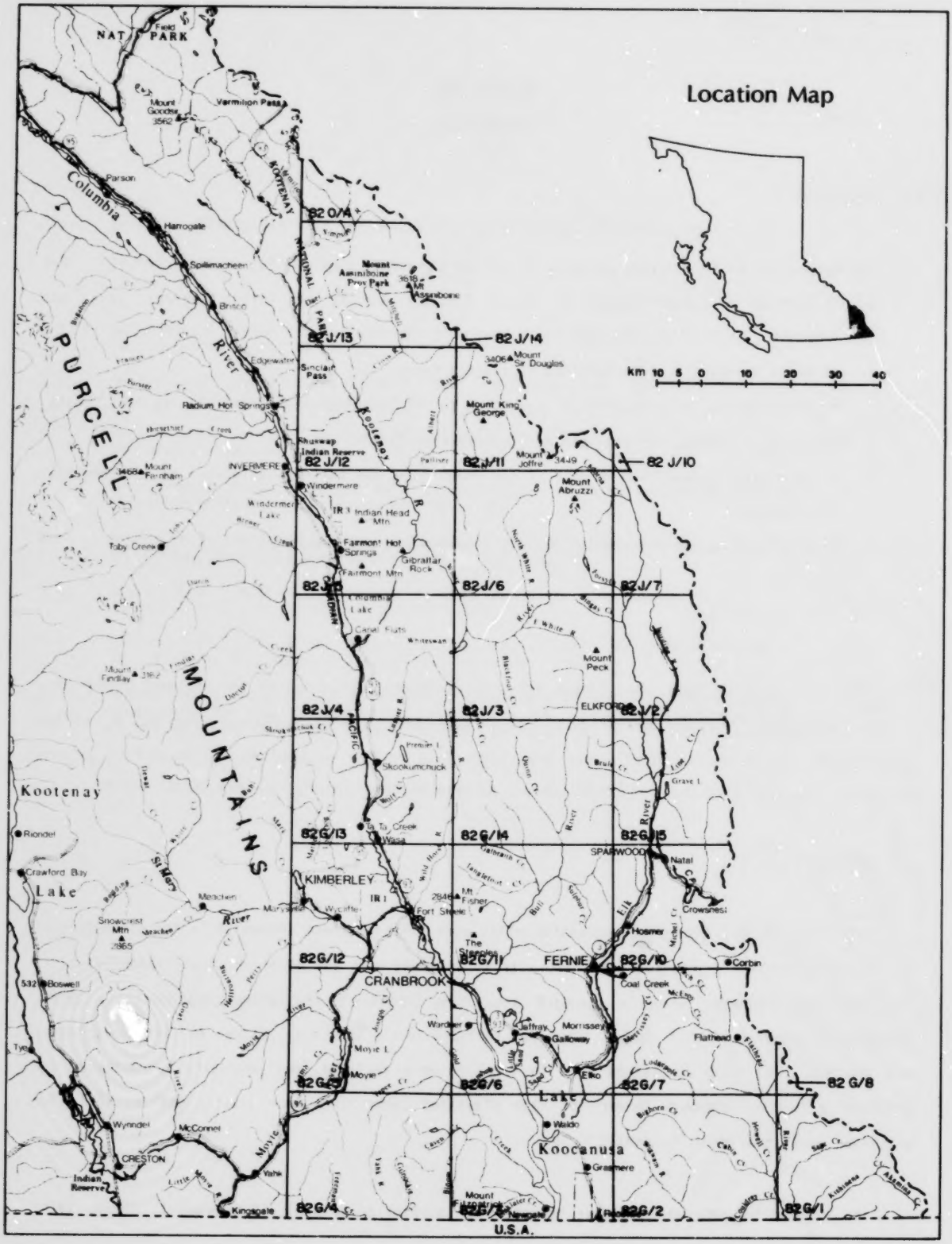

Figure 1.1 Location map (with 1:50 000 NTS grid).

McNaughton-Smith, 1965). For this analysis the two hundred most common species for the area were used. One hundred and thirty-eight vegetation types were defined with the aid of this analysis. These are presented in Volume 3 of this report.

Information concerning the distribution of tree species and other dominant vegetation was collected for the area and was applied to define Forest Zones and Subzones according to the system of classification developed by the Resource Analysis Branch (van Barneveld, 1976) and outlined below.

1.4 INTRODUCTION TO THE CLASSIFICATION SYSTEM AND ITS GENERAL APPLICATION

Biophysical Forest Zonation[1] is based on the distribution of dominant vegetation, as attributable to climatic factors. The Forest Zonation classification is composed of four levels:

1. Forest Region
2. Forest Section
3. Forest Zone
4. Forest Subzone

The Forest Zones and Subzones are the foundation of this classification from which the upper categories are derived.

1.4.1 FOREST REGION

A Forest Region is characterized by a definitive pattern of Forest Zones, developed under direct influence of a broadly homogeneous climate (macro) and topography. These vegetation patterns determine many of the resources that exist for a range of uses including forestry, agriculture, wildlife and recreation. In a given Forest Region, the vegetation resources and environmental limitations such as the severity of the winters, the precipitation patterns, snowmelt and runoff characteristics, the occurrence of drought, fire hazards, the range of vegetative variation, the pattern of soils and terrain and many other natural conditions broadly determine the social structures and economic opportunities and constraints for the area.

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1 For a description of the philosophy and definitions of this classification, see van Barneveld (1976) and Walmsley and van Barneveld (1977).

1.4.2 FOREST SECTION

Forest Sections are subdivisions of a Forest Region. They display recognizably different Forest Zonation patterns resulting from variations in climate within the Forest Region. Sections may indicate areas of different wildlife habitats due to vegetation diversity, in tree growth and forest stand structure, in agricultural potential and in snow depths or wildfire hazards.

1.4.3 FOREST ZONE

In forested area, such as much of the study area, a Forest Zone is an area over which certain shade tolerant tree species become dominant if disturbance of the vegetation does not occur. The Forest Zone is characterized by a consistant vegetative pattern on similar sites. Zones reflect differences that are significant to wildlife habitat, constraints for logging plans and site preparation, species for planting, road building, frost penetration, agriculture potential, and other land uses.

1.4.4 FOREST SUBZONE

The Forest Subzone, a subdivision of the Forest Zone, has a characteristic combination of species associated with sites that have been disturbed in recent decades or even centuries reflecting a more refined uniformity of climate. Within a subzone specific species can be recommended for planting. The occurrence of specific browse or forage may be directly associated with a certain subzone. Snow depths and climate-related capabilities to produce trees, forage or agricultural crops are often associated with a subzone.

The Forest Regions, Sections, Zones and Subzones for the East Kootenay are shown in Table 2.2. Forest Zonation maps at a scale of 1:50,000, delineating Forest Regions, Zones and Subzones, as well as Vegetation Landscape Units, are available for the study area (see Appendix B).

CHAPTER TWO

REGIONAL VEGETATION

2.1 CLIMATE AND BROAD VEGETATION PATTERNS[1]

The distribution of vegetation is influenced by a combination of climate, soils, geology, surficial geology, topography, disturbance history and characteristics of plants.

Climate determines the pattern of Forest Zones and Subzones and therefore determines the extent of Forest Regions and Sections. Climate data for various climatic locations in the East Kootenay area (Figure 2.1) and Nelson (which is located 100 km west of the study area) are shown in Table 2.1. Precipitation, temperature and the length of growing season are important determinants of broad vegetation patterns.

The study area is influenced by maritime air from the southwest, continental arctic air and continental air from the southeast. The dominating influence of the southwestern airflows is evident from the difference in annual precipitation between Nelson (763 mm), which is on the windward side of the Purcell Mountain Range and Cranbrook Airport (438 mm), which is on the leeward side of this mountain range. Nelson is located in the Interior Wet Belt Region while Cranbrook is in the Dry Interior Region. This Interior Wet Belt Region, characterized by the occurrence of western hemlock and western red cedar, extends into the southwestern portion of the study area surrounding Moyie Lake. The Interior Wet Belt Region is generally composed of closed forests with relatively good tree growth. In the Dry Interior Region droughty conditions cause more open forests, which are composed of Rocky Mountain Douglas-fir and ponderosa pine at lower elevations.

Continental arctic air frequently extends over the area in winter months. January temperatures are lower in the northern portion of the Rocky Mountain Trench than in the southern portions (Table 2.1). A difference in the January Mean Temperature in excess of 3.5° C occurs between Newgate in the Cranbrook Section, which extends southward from Columbia Lake, and Radium in the Radium Section, which extends northward from Columbia Lake.

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[1] Much of this discussion is based on information from Chilton (personal communication) and Davis (personal communication).

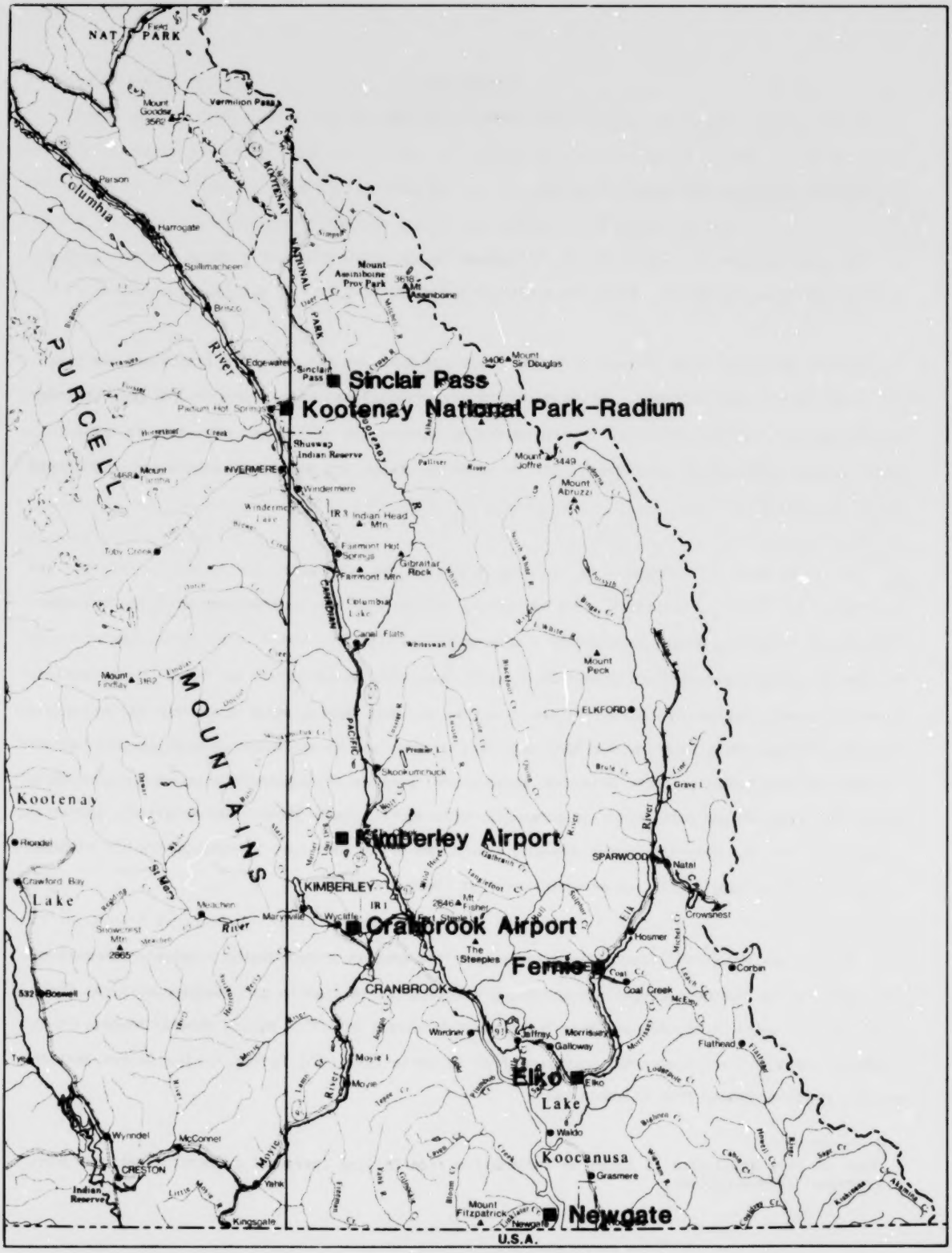

Figure 2.1 Locations of Climate Stations(see Table 2.1)

TABLE 2.1
SELECTED CLIMATE DATA[1] FOR VARIOUS LOCATIONS IN EAST KOOTENAY AREA

Forest Region	Forest Section	Station	Climate Parameter								Forest Zone/Subzone
			Mean Annual Precipitation (mm)	May to September Precipitation (mm)	Mean Annual Temperature (°C)	July Mean Temperature (°C)	January Mean Temperature (°C)	Growing[2] Degree Days (°C)	Freeze[2] Free Period (Days)	Elevation of Station (m)	
Dry Interior Region	Cranbrook Forest Section	Kimberley Airport	377.6	162.5	4.9	17.7	- 9.1	1448	92	915	Interior Rocky Mountain Douglas-fir zone: Ponderosa pine subzone
		Newgate	410.2	160.3	6.4	18.7	- 6.8	1653	108	700	Interior Rocky Mountain Douglas-fir zone: Ponderosa pine subzone
		Cranbrook Airport	437.9	178.9	5.1	17.8	- 8.9	1464	127	915	Interior Rocky Mountain Douglas-fir zone: Western larch - ponderosa pine subzone
		Elko	579.9	260.1	6.3	18.8	- 6.2	1620	131	940	Interior Rocky Mountain Douglas-fir zone: Western larch - ponderosa pine subzone
	Radium Forest Section	Kootenay National Park - Radium	511.2	285.8	4.0	16.8	-10.4	1260	105	1085	Interior Rocky Mountain Douglas-fir zone: Lodgepole pine subzone
		Sinclair Pass	607.9	296.3	1.6	13.4	-11.2	814	47	1170	Subalpine Engelmann spruce - Alpine fir zone: Rocky Mountain Douglas-fir - lodgepole pine subzone
Interior Wet Belt Region		Nelson (out of study area)	763.0	274.8	8.5	20.4	- 3.2	1158	157	540	Interior western hemlock - western red cedar zone
		Fernie	1081.5	303.7	4.5	16.4	- 8.3	1256	98	1000	Interior western red cedar zone

1 Data from Environment Canada, Atmospheric Environment Service, Canadian Normals Volume I-SI-Temperatures and Volume II-SI Precipitation
2 Calculated by Climate Unit - Air Studies Branch, B.C. Ministry of Environment (Degree Days above 5.6° C)

Continental air masses originating in the Great Basin States of the United States also affect the climate of the study area (Hare and Thomas, 1979). In winter this air is dry and cool while summer air is hot and dry. As well, in summer, Tropical Continental air masses, originating in the southwestern United States and northwestern Mexico, extend into the study area bringing hot, dry air (Kerr, 1950). This air helps to create a summer temperature gradient from warmer in the south to cooler in the north. A maximum temperature gradient in excess of 2.0° C for July Mean Temperatures occurs between Newgate and Radium. This influence helps to create severe moisture deficits throughout much of the growing season, particularly at lower elevations. In the vegetation this is reflected in open to parkland forests and grassland communities in the lower elevations of the Rocky Mountain Trench.

Within the Rocky Mountains and associated valleys of the Elk River, Flathead River and upper Kootenay River, generally lower temperatures and higher precipitation occurs than in the Rocky Mountain Trench. Northwards in these river valleys, temperatures decrease (Chilton, personal communication). This area is mostly within the Radium Section of the Dry Interior Region.

Certain areas in the mountains may be subject to convergence of air masses resulting in higher precipitation. This is illustrated by the climate data for Fernie (Table 2.1) which shows significantly higher precipitation than other stations. South of Fernie and in Little Van Creek, Sand Creek and Lodgepole Creek this convergence is reflected in occurrences of Interior Wet Belt vegetation.

At higher elevations the Subalpine Engelmann spruce - alpine fir zone and Alpine tundra zone replace the Interior Rocky Mountain Douglas-fir zone in response to increasing precipitation, decreasing temperature and shorter growing seasons (Table 2.1). Greater amounts of snow and increased snow duration result (Chilton, personal communication). Above approximately 2200 m on gentle topography, deep snowpack restricts establishment of trees and causes parkland forests to be intermixed with meadows. Above 2300 m on steeper topography, climate restricts tree growth and establishment creating krummholz communities. Harsh climate above 2450 m prevents tree establishment. This corresponds with the Alpine tundra zone.

Aspect further influences the distribution of vegetation. On south to southwest facing slopes most species generally extend to higher elevations than on other aspects. Southern aspects receive

greater amounts of solar radiation. Consequently, temperatures are warmest, snow cover least prolonged and drought conditions most severe. The vegetative cover is frequently open and revegetation is difficult.

2.2 FOREST ZONATION FOR THE EAST KOOTENAY AREA

Reflecting the climatic trends discussed in the previous section, the East Kootenay study area includes two Forest Regions. The majority of the study area, which is influenced by warm, dry air masses, is within the Dry Interior Region. The southwestern corner of the study area and some valleys in the Rocky Mountains, influenced by moister climate, are within the Interior Wet Belt Region. The Forest Regions and Sections for the East Kootenay study area are depicted in Figure 2.2. The Forest Sections, Zones and Subzones are shown in Table 2.2 which also lists approximate altitudinal limits for each subzone. A map of the Regions, Zones and Subzones is in the back pocket of this volume.

2.2.1 DRY INTERIOR REGION

The Dry Interior Region is characterized by the occurrence of the Interior Rocky Mountain Douglas-fir zone at low elevations and the Subalpine Engelmann spruce - alpine fir zone and the Alpine tundra zone at higher elevations. The Dry Interior Region includes the Radium Forest Section and the Cranbrook Forest Section (Figure 2.2), based on the distribution of ponderosa pine and associated species. The vertical sequences of zones and subzones for the Radium and Cranbrook Sections are shown in Figure 2.3.

The Cranbrook Section occurs in the Rocky Mountain Trench extending from the north end of Columbia Lake south to the United States border and is characterized by the occurrence of two subzones which have of ponderosa pine (Figure 2.3). This Section represents the dryest and warmest part of the East Kootenay area which is reflected in characteristic open stands of trees and poorer tree growth than other areas. The long growing season of this Section create the more favourable conditions for agriculture in the East Kootenay area. Within this Section, a mosaic of open and closed forests creates a diversified habitat for wildlife. The open forest stands allow good production of shrubs and grass species, creating high grazing and browsing values for livestock as well as wild ungulates.

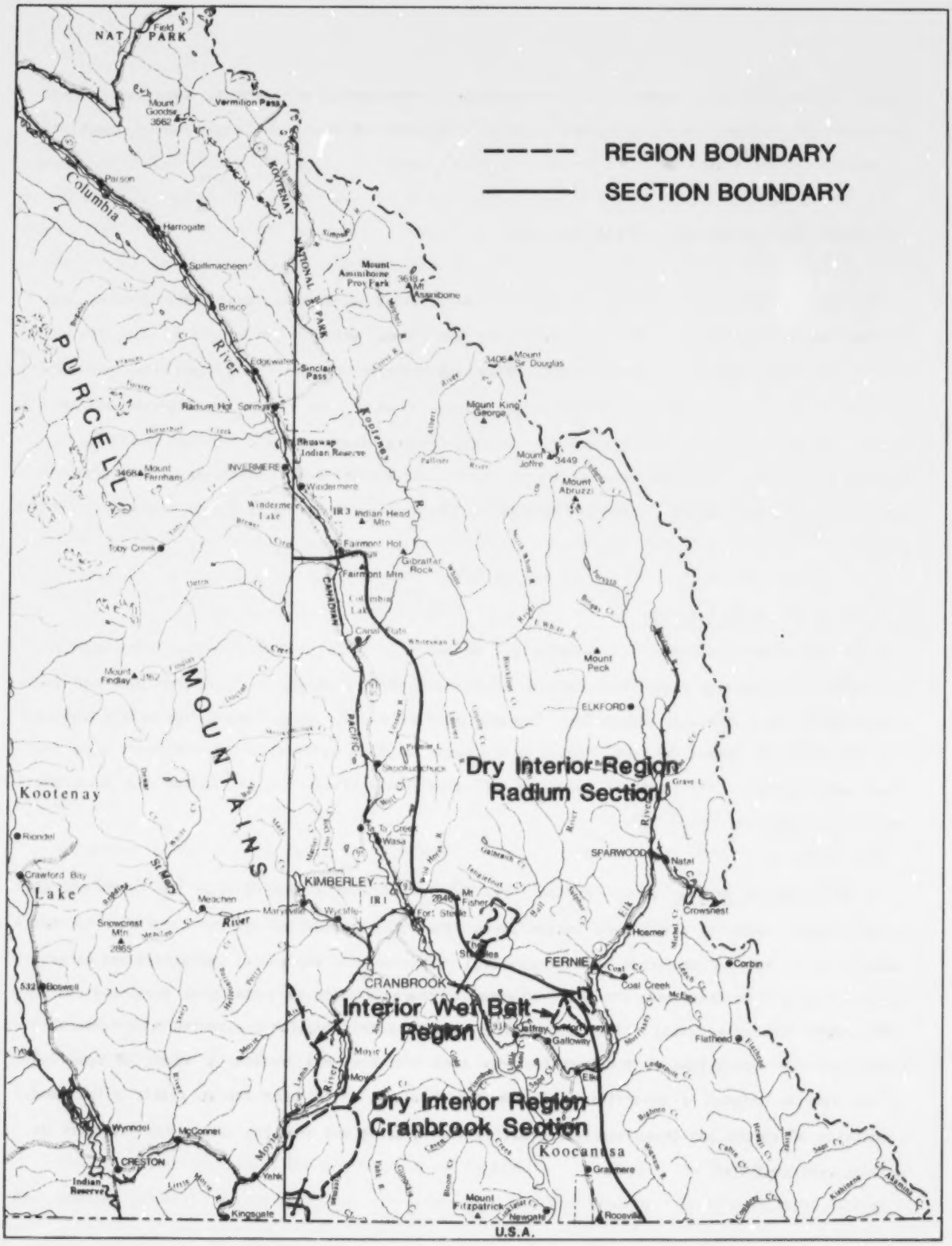

Figure 2.2 Forest Regions and Forest Sections of the East Kootenay Area

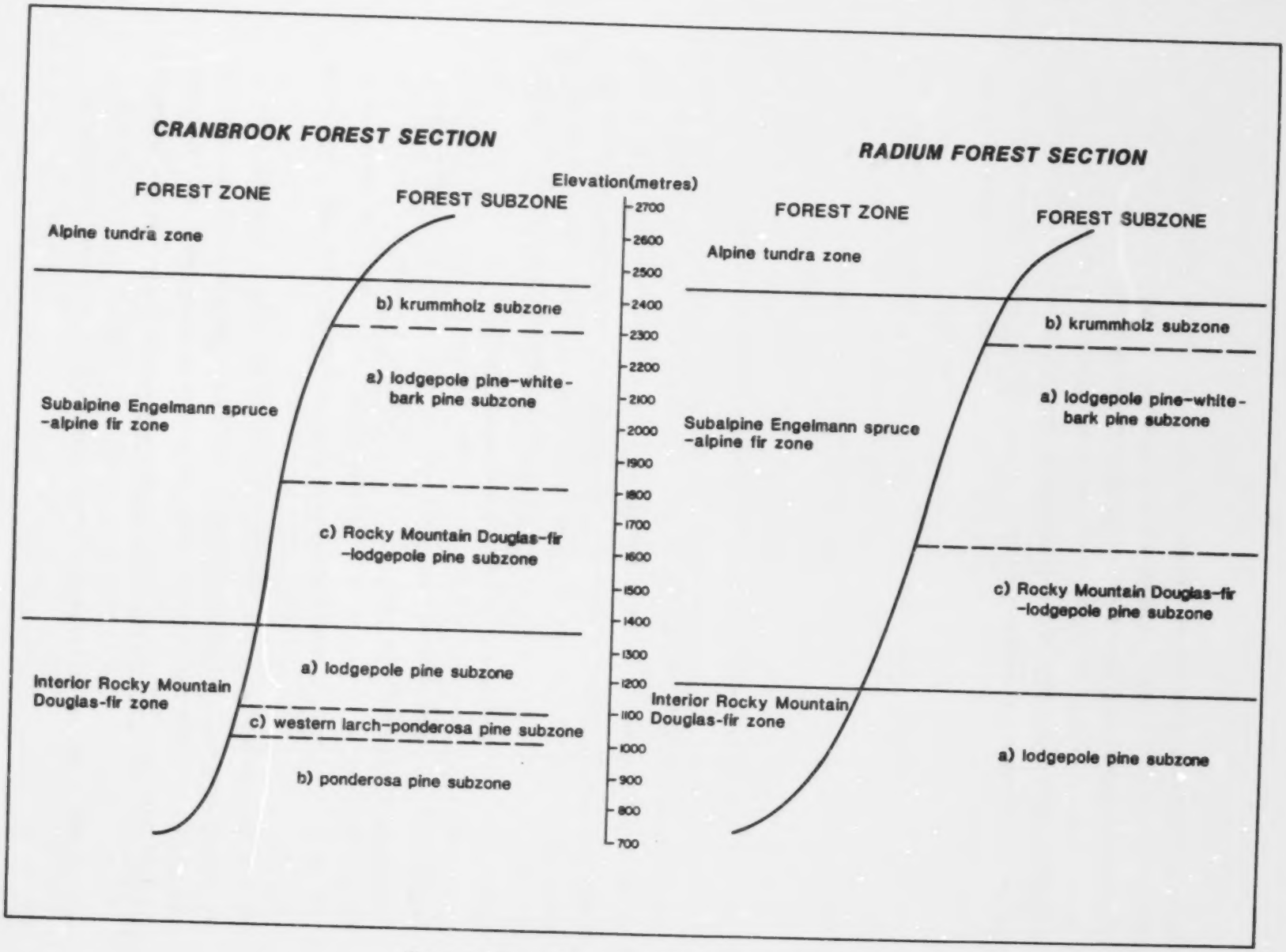

Figure 2.3 Forest Zonation of the Dry Interior Region

TABLE 2.2
FOREST ZONATION FOR THE EAST KOOTENAY AREA1

Forest Region	Forest Section	Forest Zone	Forest Subzone	Elevational Limits2 (m)		General Location
				Lower	Upper	
Dry Interior Region	Cranbrook Forest Section	Interior Rocky Mountain Douglas-fir Zone	Ponderosa pine subzone (with ponderosa pine and lacks western larch as potential seral species)	valley bottom	1000 (1350)	
			Western larch-ponderosa pine subzone (with ponderosa pine and western larch as potential seral species)	1000 (750)	1050 (1500)	
			Lodgepole pine subzone (lacks ponderosa pine as a potential seral species)	1050 (1500)	1350 (1800)	
		Subalpine Engelmann Spruce - Alpine Fir Zone	Rocky Mountain Douglas-fir-lodgepole pine subzone (with Rocky Mountain Douglas-fir as a potential seral species)	1350 (1800)	1800 (2100)	Rocky Mountain Trench from United States border north to the north end of Columbia Lake.
			Lodgepole pine-whitebark pine subzone (lacks Rocky Mountain Douglas-fir as a potential seral species)	1800 (2100)	2300	
			Krummholz subzone (trees have stunted growth form and are layered in island patterns)	2300	2450	
		Alpine Tundra Zone	Subzones have not been determined	2450	mountain top	
	Radium Forest Section	Interior Rocky Mountain Douglas-fir Zone	Lodgepole pine subzone (lacks ponderosa pine as a potential seral species)	valley bottom	1200 (1350)	
		Subalpine Engelmann Spruce - Alpine Fir Zone	Rocky Mountain Douglas-fir-lodgepole pine subzone (with Rocky Mountain Douglas-fir as a potential seral species)	1200 (1350)	1650 (2000)	Rocky Mountain Trench north of Columbia Lake; Kootenay River from Canal Flats through Kootenay Park; Elk River area from Elko north through the Elk River watershed; Flathead River watershed
			Lodgepole pine - whitebark pine subzone (lacks Rocky Mountain Douglas-fir as a potential seral species)	1650 (2000)	2300	
			Krummholz subzone (trees have stunted growth form and are layered in island patterns)	2300	2450	
		Alpine Tundra Zone	Subzones have not been determined	2450	mountain top	
Interior Wet Belt Region		Interior Western Hemlock-Western Red Cedar Zone	Rocky Mountain Douglas-fir-lodgepole pine-western larch subzone (lacks alpine fir and Engelmann spruce as potential seral species)	1200	1350	Moyie Lake area and various side valleys throughout the southwestern part of the study area including a small area of the Elk Valley south of Fernie.
			Lodgepole pine-Engelmann spruce-alpine fir subzone (with alpine fir and Engelmann spruce as a potential seral species)	1350	1650	
		Interior Western Red Cedar Zone	Rocky Mountain Douglas-fir subzone (lacks alpine fir and Engelmann spruce as potential seral species)	valley bottom	1350	
			Lodgepole pine-Engelmann spruce-alpine fir subzone (with alpine fir and Engelmann spruce as potential seral species)	1350	1500	
		Subalpine Engelmann Spruce - Alpine Fir Zone	Forested Subzone	1500	2300	

1 See text for explanation of this table.
2 Elevation limits listed are approximate. Those in parenthesis are extremes, usually found on south to southwest facing slopes. See Appendix B for availability of Forest Zonation Maps which have distribution of Regions, Zones and Subzones.

The Radium Section is located in the Rocky Mountain Trench, north of Columbia Lake, and throughout the valleys and mountain ranges of the Rocky Mountains (Figure 2.2). It is climatically cooler and moister (Chilton, personal communication). The subzones which have ponderosa pine are not found in this Section. In general it has more closed forests and better tree growth than the Cranbrook Section creating better forestry values throughout much of its area. Wildlife values are high in much of this Section. The open areas of southern exposures at lower elevations provide good habitat for overwintering animals.

The Radium and Cranbrook Sections have the following Forest Zones:

1. Interior Rocky Mountain Douglas-fir zone
2. Subalpine Engelmann spruce - alpine fir zone
3. Alpine tundra zone

2.2.1.1 INTERIOR ROCKY MOUNTAIN DOUGLAS-FIR ZONE

Climatic climax forests in this zone are formed by Rocky Mountain Douglas-fir usually with an understory of birch-leaved spirea and pine grass. This zone occurs at lower elevations in the Dry Interior Region extending from valley bottom to about 1350 m in the Cranbrook Section and to 1200 m in the Radium Section (Figure 2.1). On dry, south and southwest facing slopes this zone may extend upwards to 1800 m in the Cranbrook Section and to 1350 m in the Radium Section.

Due to frequent fires and extensive logging within this zone in the past, plant communities are frequently in young successional stages. Cooler and moister conditions within the Radium Section result in a wider occurrence of more mature and climatic climax communities than in the Cranbrook Section. Common seral tree species vary with subzone and include lodgepole pine, ponderosa pine and western larch. Seral characteristics are further discussed by subzone.

Within this zone a typical Rocky Mountain Douglas-fir climatic climax does not occur on excessively wet soils or on excessively dry soils. In these areas edaphic climax communities will be formed by willows, black cottonwood, white spruce, western red cedar (wet soils) or ponderosa pine (dry soils).

On gravel bars which have high water tables occurring throughout the year and on areas that are

frequently flooded, willow thickets may dominate and form an edaphic climax. These areas usually have poorly aerated soils (gleysolic soils). Such areas are common along the Kootenay River south of Canal Flats.

In areas of periodic flooding which have well aerated, recently deposited soils (regosols), black cottonwood dominates the vegetation. These areas frequently have a tall, dense, shrub layer dominated by red-osier dogwood. Areas dominated by black cottonwood are common along the Kootenay River, Elk River and near the mouth of the St. Mary's River.

On wide floodplains that are inundated less frequently, white spruce and black cottonwood occur. Red-osier dogwood and common horsetail are frequently found in the understory. The soils on these sites are moderately well-drained to imperfectly drained. Stands of this type are common in the Elk River valley. In early stages of succession, these floodplain areas may be dominated by seral species such as willows and, in areas of higher base status, trembling aspen.

Lower slopes and valley floors that receive moisture or seepage from the adjacent slopes, may be covered with stands of white spruce. The understory is commonly dominated by common horsetail and moss. The runoff from the adjacent slopes enriches the soils with nutrients. Lodgepole pine and Rocky Mountain Douglas-fir frequently act as seral species in these areas. Extensive white spruce sites are generally restricted to the upper Kootenay River[2] and upper Elk River in the Radium Section, as well as locally throughout the study area.

In the side valleys of the Rocky Mountain Trench and along the Albert River and the White River, western red cedar may form edaphic climax stands in response to cooler conditions and additional moisture and nutrients from seepage. This usually occurs in lower slope positions in areas with relatively calcareous soils.

In depressional areas and valley floor areas with excessive moisture various wetland communities are found. Fen communities, which are dominated by sedges, occur along the Columbia River, Kootenay

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2 Further investigation of the Kootenay River valley within Kootenay National Park may determine the existence of a climatic climax zone of hybrid spruce as has been suggested by Utzig (personal communication).

River, Elk River and in depressional areas throughout the study area although such communities are limited in extent.

Marsh communities, dominated by cattails and other herbaceous vegetation, occur in wet, nutrient rich sites. These communities grow in calcareous to mildly acidic mineral substrate often capped with muck.

Meadow communities are found in other depressional or level floodplain areas reflecting good moisture availability, usually from a seasonally high water table. These communities are dominated by herbaceous plants which grow on mineral soils which have high organic matter content in the upper portion. Such a community, dominated by rushes, occurs north of Athalmer in the Columbia River floodplain.

In the Cranbrook Section, dry edaphic ponderosa pine parkland and open forest stands are representative of coarse-textured fluvial and silty-textured lacustrine materials at lower elevations in the Rocky Mountain Trench. Soils derived from these materials are extremely droughty. Drought, combined with high lime content of the soils and high soil surface temperatures, inhibits regeneration of Rocky Mountain Douglas-fir. The lower vegetation of these areas is typically dominated by common rabbitbrush, antelopebush, common saskatoon, bluebunch wheat grass and prairie koeleria. Needle grasses and drooping brome grass may dominate early seral vegetation. Succession on these sites occurs slowly. For a more detailed description of areas with ponderosa pine the reader is referred to Brayshaw (1970).

The Interior Rocky Mountain Douglas-fir zone consists of three subzones: the Ponderosa pine subzone, the Western larch-ponderosa pine subzone and the Lodgepole pine subzone.

Ponderosa Pine Subzone

In this subzone, characteristically, ponderosa pine is a potential seral component and western larch cannot successfully establish.

This is the lowest subzone of the Interior Rocky Mountain Douglas-fir zone and occurs from valley bottom to approximately 1000 m. On south to southwest facing slopes the ponderosa pine subzone may extend to 1350 m. This subzone is the dryest and warmest of the Interior Rocky Mountain

Douglas-fir zone as is indicated by the climate information for Kimberley Airport and Newgate (Table 2.1). This subzone is only found within the Rocky Mountain Trench area in the Cranbrook Section.

The seral stands of this subzone are dominated by ponderosa pine as a result of a warm, dry climate. Frequently, Rocky Mountain Douglas-fir is present intermixed with ponderosa pine in seral stands. In cooler, moist locations in this subzone, lodgepole pine and trembling aspen may also be found.

In this subzone, forest stands are generally open in response to soil moisture deficits which inhibit regeneration of trees. The understory is dominated by shrubs such as antelopebush, common rabbitbrush and common saskatoon, and grasses such as bluebunch wheat grass, rough fescue, Idaho fescue and prairie koeleria. Plate 2.1 illustrates typical vegetation within the ponderosa pine subzone.

Stands within this subzone have remained open due to livestock grazing and ground fires. Regeneration is inhibited by high surface temperatures, severe moisture deficiencies and high lime content in the soil.

Plate 2.1: Typical vegetation of the Interior Rocky Mountain Douglas-fir zone: ponderosa pine subzone, here composed of parkland ponderosa pine and an understory of common rabbitbrush and prairie koeleria.

Areas supporting ponderosa pine are slow to succeed to climax stands of Rocky Mountain Douglas-fir. Historically the high frequency of fires, logging and intensive grazing prevented domination by the climax species. However, fire control practices and controlled livestock grazing pressures of recent times have resulted in a substantial increase in tree cover and frequency of Rocky Mountain Douglas-fir.

The soils of this subzone are most commonly classified Orthic Eutric Brunisols (Lacelle, in preparation). On dry sites, Orthic Dark Brown Chernozems may be found under grassland vegetation.

Western Larch - Ponderosa Pine Subzone

The Western larch-ponderosa pine subzone is found from approximately 850 m to 1050 m in elevation. Western larch and ponderosa pine are potential seral species of this subzone. On exposed south to southwest facing slopes this subzone may extend to 1500 m. This subzone is located between the Ponderosa pine subzone and the Lodgepole pine subzone of the Interior Rocky Mountain Douglas-fir zone and is restricted to the Cranbrook Section. Its climate is intermediate to the other two subzones as indicated by the climate information for Cranbrook and Elko (Table 2.1). In comparison with the ponderosa pine subzone, this subzone receives more precipitation while evapotranspiration is

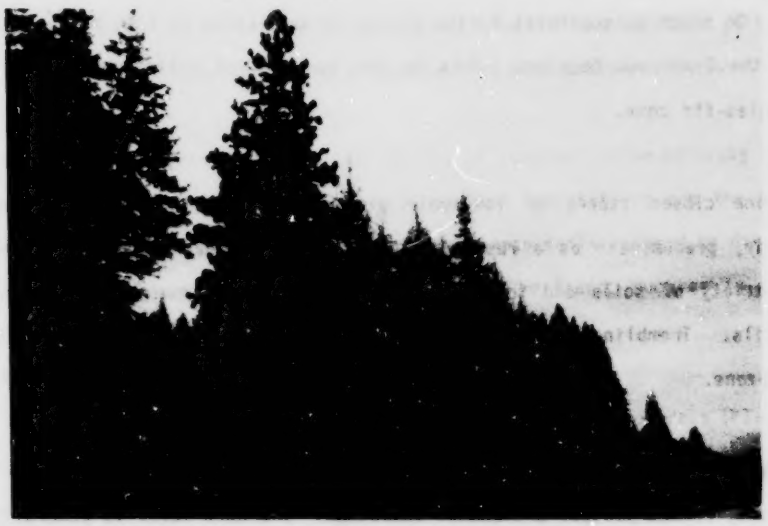

Plate 2.2: Stands within the Interior Rocky Mountain Douglas-fir zone: western larch-ponderosa pine subzone are generally dominated by western larch and ponderosa pine as shown here. The understory is dominated by soopolallie, common saskatoon, common juniper and pine grass.

lower because of lower temperatures. The increase in available soil moisture allows western larch to grow.

Seral stands in this subzone are dominated by ponderosa pine and western larch, with varying amounts of Rocky Mountain Douglas-fir, lodgepole pine and trembling aspen. Stands are commonly more closed than in the ponderosa pine subzone and the understory is dominated by soopolallie, birch-leaved spirea, common saskatoon and pine grass. Typical vegetation for this subzone is seen in Plate 2.2. In areas of droughty coarse-textured soils, stands may be more open and dominated by ponderosa pine with an understory of common saskatoon and bluebunch wheat grass. On more protected sites Rocky Mountain Douglas-fir is able to regenerate in the shade of the closed canopies of this subzone.

The soils of this subzone are commonly classified as Orthic Eutric Brunisols (Lacelle, in preparation). On finer textured materials Orthic Gray Luvisols may be found.

Lodgepole Pine Subzone

Lodgepole pine is the major seral species of this subzone. This subzone lacks ponderosa pine as a potential seral species. This is the upper subzone of the Interior Rocky Mountain Douglas-fir zone and it occurs from valley bottom to 1200 m in the Radium Section and from 1050 m to 1350 m in the Cranbrook Section. On south to southwest facing slopes it may extend to 1350 m in the Radium Section and to 1800 m in the Cranbrook Section. This is the coolest and wettest subzone of the Interior Rocky Mountain Douglas-fir zone.

In this subzone closed stands of lodgepole pine, with or without western larch and Rocky Mountain Douglas-fir, predominate as a result of past forest fires. These tree species are seral components on a variety of soils and topographic positions. They dominate on mid-slope areas of medium-textured soils. Trembling aspen and common paper birch may be present as minor components throughout this subzone.

The understory is generally dominated by shrub species such as soopolallie, birch-leaved spirea, creeping Oregon-grape, common juniper and common saskatoon. The herb layer is generally dominated by pine grass and has various combinations of heart-leaved arnica, showy aster, northern twinflower and dwarf blueberry. Plate 2.3 illustrates typical vegetation of this subzone.

Plate 2.3: Typical vegetation of the Interior Rocky Mountain Douglas-fir zone: lodgepole pine subzone. This seral stand is dominated by lodgepole pine with Rocky Mountain Douglas-fir regeneration. The understory is dominated by soopolallie, common saskatoon, pine grass and Canadian bunchberry. This site is on a river terrace.

On fine to medium-textured soils, particularly on areas with luvisolic soils, western larch tends to dominate seral stands. Because of better moisture and nutrient status associated with these soils, the understory tends to be more diverse and may contain species such as Utah honeysuckle, Canadian bunchberry, western meadow-rue and a dense cover of pine grass and moss.

On dry sites, poor regeneration causes open stands of lodgepole pine or Rocky Mountain Douglas-fir to dominate. Severe moisture deficits and high surface temperatures are the primary causes of this. Such conditions may be found on steep slopes and coarse soils exposed to direct sun heat. On very steep, unstable, south facing slopes, limber pine may be found, such as in the Shuswap Creek area.

Stands of lodgepole pine, with an understory of soopolallie and pine grass (Plate 2.3), dominate on coarse-textured soils of fluvial terraces. These sites are dry and deficient in nutrients. Sites with this kind of vegetation occur more frequently in the Radium Section than in the Cranbrook Section, as such terraces are usually associated with the lower subzones within the Cranbrook Section.

Trembling aspen may act as the dominant seral species on sites that have been repeatedly or severely burnt. These broadleaf stands show a preference for basic to slightly acidic soils, frequently on dry, south to southwest facing slopes and sometimes in gullies. Trembling aspen may regenerate from underground roots after severe fires which may consume conifer seeds, thus removing competition for trembling aspen.

A seral condition restricted to the Radium Section, on slopes north of Fernie, is where seral trembling aspen and black cottonwood[3] occur, along with lesser amounts of lodgepole pine and Rocky Mountain Douglas-fir. Black cottonwood is normally found on sites influenced by flooding and periodically high water tables. In the Fernie area the occurrence of this species on mountain slopes is attributed to more available soil moisture, cooler temperatures and increased precipitation. High base status of the soils and repeated and intensive fires have promoted the establishment of trembling aspen.

Thin-leaved mountain alder, a species with the ability to fix nitrogen, may be one of the early species to revegetate an area after a fire. It often forms a dense thicket which inhibits the establishment of tree species.

The soils within this subzone are commonly classified as Orthic Eutric Brunisols on medium to coarse textured materials and Brunisolic Gray Luvisols on finer-textured materials (Lacelle, in preparation). These soils are typically deficient in nitrogen.

2.2.1.2 SUBALPINE ENGELMANN SPRUCE - ALPINE FIR ZONE

Engelmann spruce and alpine fir are the climatic climax species for this Forest Zone. This zone generally extends from a lower limit of 1200 m in the Radium Section and 1350 m in the Cranbrook Section up to 2400 m throughout the area. On exposed south to southwest facing slopes the lower limit may extend upwards from 1350 m in the Radium Section and 1800 m in the Cranbrook Section to 2400 m. This zone is subject to higher precipitation, lower temperatures and a shorter growing season than the Interior Rocky Mountain Douglas-fir Zone as is illustrated in the climate data for Sinclair Pass (Table 2.1).

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[3] The black cottonwood found in this area may be a balsam poplar-black cottonwood hybrid (Dick, personal communication). Further study may confirm this and would suggest succession influenced by boreal climate.

Of the two climatic climax species, alpine fir appears to be able to grow on a wider variety of sites than Engelmann spruce. Varying amounts of both species are usually found on most intermediate sites. Engelmann spruce may dominate stands found in rich valley bottom and valley side sites. At elevations near tree line, alpine fir dominates with Engelmann spruce usually present in small amounts or absent. Alpine larch and whitebark pine are characteristic species at these higher elevations. Due to the open nature of these stands and the longevity of these species, they usually remain as a component of the stands.

The understory vegetation of climax stands varies from lower elevations to higher areas but commonly is dominated by smooth Pacific menziesia and grouseberry with various other shrubs and herbs and a continuous moss cover.

After fire, logging or other disturbance, areas within this zone are generally inhabited by opportunistic herbs such as fireweed and shrubs such as black swamp gooseberry and blue elder. These species are progressively replaced by trees and their corresponding plant communities. Sometimes following fire alder will revegetate sloped areas and replenish the nitrogen content of the soils. Its abundance may retard succession to coniferous trees. However, in the long term the fixed nitrogen may significantly improve the growth of the coniferous species that establish on these sites.

Typically, lodgepole pine dominates seral stands in most of this zone. At higher elevations (above 2000 m), lodgepole pine, whitebark pine and alpine larch dominate. At lower elevations of this zone seral Rocky Mountain Douglas-fir is usually mixed with lodgepole pine and western larch. Trembling aspen may occur in mixed stands and sometimes it may dominate. Throughout this zone some Engelmann spruce or alpine fir may occur in seral stands. Plate 2.4 illustrates seral stands within this zone. Seral characteristics are further discussed by subzone.

Sites supporting edaphic vegetation are encountered most frequently in the Radium Section but avalanche chutes occur throughout the zone in both Sections. Frequent avalanching and excessive moisture results in treeless communities of Sitka mountain alder with a lush understory of herbs dominated by common cow-parsnip, western meadow-rue, green false hellebore and grasses. The steeper, upslope areas of these chutes are dominated by alder while the more level, wetter, nutrient enriched areas at the toe of the chute are usually herb dominated.

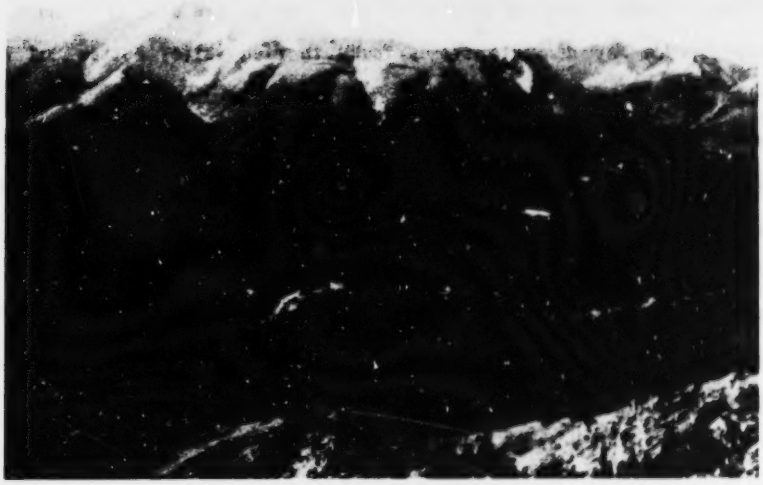

Plate 2.4: Seral stands of closed canopied lodgepole pine dominate the Elk River valley, here, near the Greenhills Range. Most of this area is within the Subalpine Engelmann spruce-alpine fir zone.

On floodplains of the Radium Section, frequently flooded gravel bars, support pioneer communities of willows. These sites are usually characterized by high water tables and have gleysolic soils. On other periodically flooding parts of these floodplains black cottonwood forms climax stands. The recent, usually coarse to medium-textured surficial deposits (regosols) frequently support red-osier dogwood in the understory.

Engelmann spruce and black cottonwood may form edaphic climax stands on areas that are characterized by less frequent flooding and more weathered soils. These soils generally have high water tables for part of the year and are moderately well to imperfectly drained. Favourable moisture and nutrient conditions result in relatively good tree growth. Trembling aspen and willows may act as seral species on these sites.

Wetland communities may be found in depressional areas or in valley floor areas. Fens, dominated by sedges, are the most common wetland community. The sedges grow on calcareous to mildly acidic organic substrate fed by mineral rich ground water. Decomposition of organic material is relatively slow in these areas. The water table reaches the surface for part of the year replenishing the mineral supply to the rooting zone. Typical fen communities are found south of Elk Lakes

Park along the Elk River and south of the Fording Coal Mine along the Fording River.

Sphagnum moss bog vegetation, cattail dominated marsh vegetation and woody plant dominated swamp vegetation occur infrequently.

Wet, treeless subalpine meadow communities generally occur at high elevations (above 2200 m) where melting snow provides ample moisture. These meadows display a colourful array of flowering and grasslike plants such as subalpine fleabane, Indian paintbrush, Sitka valerian, yellow glacier lily and various grass and sedge species. Long snow duration, dense herb growth and sod formation by grasses and sedges inhibits tree establishment. Plate 2.5 shows the typical vegetation of a subalpine meadow. Large areas of subalpine meadows are found in Mount Assiniboine Park. Similar communities occur in cirque basins and depressions throughout the higher altitudes of the East Kootenay area. Occassionally meadows are found at lower elevations on floodplains.

Plate 2.5: Subalpine meadow vegetation dominated by subalpine fleabane, yellow glacier lily, western anemone and alpine timothy. The stunted tree is alpine larch.

Dry sites, which have a characteristically open, climax vegetative cover of Rocky Mountain Douglas-fir, occur on south to southwest facing slopes. Lodgepole pine may be mixed with Rocky Mountain Douglas-fir in seral stands. Usually these sites occur on coarse-textured colluvial materials.

The Subalpine Engelmann spruce-alpine fir zone is separated into three subzones: the Rocky Mountain Douglas-fir-lodgepole pine subzone; the Lodgepole pine-whitebark pine subzone and the Krummholz subzone. All subzones are found in both the Radium and Cranbrook Sections.

Rocky Mountain Douglas-fir - Lodgepole Pine Subzone

In this subzone, Rocky Mountain Douglas-fir characteristically can grow as a seral component. This is the lowest subzone of the Subalpine Engelmann spruce - alpine fir zone. In seral stages the forested stands are dominated by Rocky Mountain Douglas-fir, lodgepole pine and western larch. The subzone is located between approximately 1350 m to 1800 m elevation within the Cranbrook Section and from 1200 to 1650 m in the Radium Section. On south to southwest facing slopes this subzone may extend from 1800 m to 2100 m in the Cranbrook Section and from 1350 to 2000 m in the Radium Section.

This subzone is subjected to a warmer, drier climate than the upper subzones (Chilton, personal communication). These conditions, combined with a relatively long growing season, allow Rocky Mountain Douglas-fir to participate in seral stands in this subzone.

On warm, south to southwest facing slopes, Rocky Mountain Douglas-fir is the dominant seral species. On cooler aspects, on medium to coarse textured materials, lodgepole pine usually dominates seral stands. Varying amounts of western larch, Rocky Mountain Douglas-fir, Engelmann spruce and alpine fir may be present. On finer textured materials, western larch may dominate although lodgepole pine occurs as well. South to southwest facing slopes that have been severely or repeatedly burned are dominated by trembling aspen with an understory of soopolallie and pine grass. Trembling aspen may also be found in minor amounts mixed in stands of lodgepole pine and Rocky Mountain Douglas-fir.

Within the Rocky Mountain Douglas-fir-lodgepole pine subzone, seral stands usually have a shrub layer dominated by birch-leaved spirea, soopolallie and rose. Pine grass, kinnickinnick, heart-leaved arnica and northern twinflower are commonly found in the herb layer. At upper elevations and on north and east facing slopes, within this subzone, smooth Pacific menziesia, Utah honeysuckle and twinberry honeysuckle are common shrub components while grouseberry may form the herb layer. A continuous cover of moss is frequently present.

On sandy or gravelly-textured terraces, which are rapidly drained, moisture poor and infertile,

lodgepole pine, with an understory of soopolallie and pine grass, dominates. These sites become dry in the summer.

The medium to coarse-textured soils of this subzone are calcareous and little leached (Orthic Eutric Brunisols). On finer textured soils, where leaching occurs even more slowly a distinct clay enriched layer may be present in the soils (Brunisolic Gray Luvisols). In cooler, moister environments on north or east aspects soils become more leached, resulting in more acidic soils (Orthic Humo-Ferric Podzols and Podzolic Gray Luvisols).

Lodgepole Pine - Whitebark Pine Subzone

In this subzone, seral stands are dominated by lodgepole pine except at higher elevations where whitebark pine may dominate. Rocky Mountain Douglas-fir is lacking as a potential seral component. This middle subzone extends from 1800 m to 2300 m in the Cranbrook Section and from 1650 m to 2300 m in the Radium Section. On south to southwest facing slopes, the lower limit may occur at 2100 m in the Cranbrook Section and 2000 m in the Radium Section while the upper limit remains approximately at 2300 m. South facing slopes at these higher elevations may experience more extreme conditions than north facing slopes, as strong wind and intense solar radiation lessen the snowpack on the south slopes, exposing the vegetation to harsh winter conditions (Ogilvie, unpublished manuscript).

Below approximately 2100 m this subzone is usually formed by closed stands of seral lodgepole pine and often some western larch. This occurs characteristically on medium to coarse textured, well-drained soils of mountain slopes. On steeper, rapidly drained slopes, the forest canopy tends to open up and western larch is rarely present. On finer-textured richer soils, (particularly with luvisolic soil development), western larch tends to dominate over lodgepole pine. Western larch is rarely found above 1900 m.

The understory shrub layer of these stands is typically dominated by smooth Pacific menziesia, white-flowered rhododendron, black blueberry and twinberry honeysuckle. The herb layer is commonly dominated by grouseberry, heart-leaved arnica, northern twinflower and Canadian bunchberry. The moss layer is usually continuous and formed by common moss, feather moss and layered moss. Typical vegetation for this subzone is shown in Plate 2.6.

At higher elevations, mainly above 2000 m, seral stands of whitebark pine dominate and are often

mixed with lodgepole pine and alpine fir. This is generally found on steep slopes and has an understory dominated by grouseberry. On steep, south to southwest facing slopes are found persistent communities dominated by open stands of whitebark pine with an understory of soopolallie and rough fescue. These areas are moisture deficient for much of the summer due to sun exposure and rapid runoff of moisture.

Plate 2.6: Typical vegetation of the Subalpine Engelmann spruce - alpine fir zone: lodgepole pine-whitebark pine subzone includes an overstory of Engelmann spruce and lodgepole pine with regeneration dominated by alpine fir. The understory is dominated by smooth Pacific menziesia, northern twinflower, Canadian bunchberry with a continuous cover of common moss.

Alpine larch is found at the upper limits of this subzone generally above 2100 m. It is often a pioneering species on recently deglaciated areas and sometimes on avalanche areas. It may also be found on exposed slopes or ridges.

On more protected sites at high elevations, open to closed stands of climax alpine fir and Engelmann spruce are found. These stands generally have an understory dominated by white-flowered rhododendron, smooth Pacific menzies'a and a continuous moss layer.

Towards the upper limits of this subzone stands tend to be open and interspersed with meadow and tundra communities. The meadows are often dominated by subalpine fleabane, Sitka valerian, sedges

and grasses, while the tundra is dominated by red mountain-heather intermixed with areas of bare soil and rock.

On sandy or gravelly-textured terraces above valley bottom areas, lodgepole pine dominates on rapidly drained, moisture deficient and infertile sites. The understory usually consists of soopolallie and pine grass. Tree growth is slow and climax species are slow to enter into the composition of these plant communities. Dry conditions occur through much of the growing season.

Trembling aspen may be found in seral stands. It often dominates on severely or repeatedly burned areas of steep south to southwest facing slopes. On these areas a vegetative cover prevents soil erosion. Succession to climax is slow.

More severely burned areas of south to west exposures lack tree cover or regeneration and are dominated by shrubs such as soopolallie, common saskatoon and birch-leaved spirea. The herb layer is dominated by fireweed and grasses such as rough fescue. Succession is slow on these sites because of dry conditions in summer and exposure to cold winter climate due to relatively low snow cover.

The soils of this subzone are usually somewhat leached and acidic in nature (Orthic Humo-Ferric Podzols) because of high precipitation. On finer-textured soils, soils with a distinct clay enriched horizon (Podzolic Gray Luvisol) may develop (Lacelle, in preparation).

Krummholz Subzone

The Krummholz subzone is characterized by the occurrence of clumps of stunted (below 3 m tall) trees. The uppermost subzone of the Subalpine Engelmann spruce - alpine fir zone, this subzone occurs between approximately 2300 m to 2450 m. Harsh climatic conditions permit establishment of trees only in milder years and in sheltered locations. Much of this area is unvegetated as it is composed of actively weathering rock and talus dominated slopes.

This subzone consists of islands of stunted and layered trees interspersed among meadows, tundra-like vegetation, or rock and talus. Plate 2.7 illustrates islands of krummholz vegetation.

Krummholz areas represent the upper limit of possible tree growth. In addition to extreme climatic conditions, desiccation due to direct exposure to the sun and strong winds further inhibit establishment of tree species.

Plate 2.7: The gradation, from open forest of the Lodgepole pine - whitebark pine subzone into tree islands of the krummholz subzone within the Subalpine Engelmann spruce - alpine fir zone, is seen on the slope on the left side of the photo. In the foreground, a stunted alpine larch occurs with cream mountain-heather, grouseberry, woolly pussytoes and alpine blue grass.

Alpine fir is the dominant tree species of tnis subzone. Engelmann spruce, whitebark pine and alpine larch may be found in lesser numbers. The understory of this subzone is commonly dominated by grouseberry, mountain-heather, grasses and sedges. In drier areas with shallow soils and bare rock, the vegetation is dominated by pioneering vegetation of white mountain-avens, woolly pussytoes, grasses and lichens. In moister sites, vegetative cover is dominated by Sitka valerian, subalpine fleabane and sedges.

Deeper soils of this subzone are characterized by a dark surface (Sombric Ferro-Humic Podzols or Orthic Melanic Brunisols) reflecting slow decomposition of organic matter in this cold environment (Lacelle, in preparation). On soils that are actively colluviating or slumping, regosolic soils occur. Much of the areas within this subzone have shallow, relatively unweathered materials overlying bedrock.

2.2.1.3 ALPINE TUNDRA ZONE

The severe climate of the Alpine tundra zone prevents the establishment of tree species. Generally this zone occurs above 2450 m.

Much of the area within this zone consists of steep rocky slopes. Where a veneer of soils occurs, low growing vegetation is usually present.

Moisture availability appears to be one of the primary controls on the type of vegetation found in the alpine tundra. On rapidly-drained, drier sites, white mountain-avens, alpine bluegrass, moss campion and lichens are common. On average sites, willows, mountain-heather, broad-leaved willow herb and mountain forget-me-not are commonly found among other herbs and grasses. On moister sites, vegetation is believed to be similar to that of subalpine meadows possibly with subalpine fleabane, Sitka valerian and sedges.

Alpine tundra vegetation is found in Mount Assiniboine Park and in small, scattered, high elevation locations throughout the East Kootenay area (Plate 2.8).

Plate 2.8: Alpine tundra vegetation occurs at the top of mountain peaks throughout the East Kootenay area. Below this zone occur the krummholz subzone and open forests of the Lodgepole pine-whitebark pine subzone of the Subalpine Engelmann spruce - alpine fir zone (photograph by Chris Clement).

The deeper soils of this zone are characterized by a dark, organic enriched surface (Orthic Melanic Brunisols) reflecting slow decomposition of organic matter in this cold environment (Lacelle, in preparation). In areas where colluvial processes are active, the soils are generally regosolic.

2.2.2 INTERIOR WET BELT REGION

Although this Forest Region lies mainly in the West Kootenays, it extends into the southwestern part of the study area, south and west of Moyie Lake. Isolated areas of this Forest Region also occur along Yahk River, Sand Creek, Lodgepole Creek, Little Van Creek (Bull River) and south of Fernie to Morrissey. This Region is subjected to higher annual precipitation than the Dry Interior Region as indicated by the climate data for Nelson and Fernie (Table 2.1).

The Interior Wet Belt Region has three Forest Zones within the East Kootenay study area. These include: the Interior western hemlock - western red cedar zone; the Interior western red cedar zone and the Subalpine Engelmann spruce - alpine fir zone. The vertical arrangement of zones and subzones within the Interior Wet Belt Region differs between the Moyie Lake area and the Fernie area. Figure 2.4 illustrates the difference in the relative position of these zones and subzones. Near Moyie Lake the Interior western hemlock - western red cedar zone occurs, while south of Fernie the Interior western red cedar zone is found. Here, western hemlock is rare because of highly calcareous soils.

2.2.2.1 INTERIOR WESTERN HEMLOCK - WESTERN RED CEDAR ZONE

Within this zone, western hemlock and western red cedar form the climatic climax. In side valleys, this zone reaches from valley bottom to approximately 1650 m. In the Moyie River Valley, south of Moyie Lake, the lower limit of this zone is 1200 m which is the upper limit of the Interior Rocky Mountain Douglas-fir zone of the Dry Interior Region. An increase in precipitation with elevation allows western hemlock and western red cedar to participate in forest stands above 1200 m. The Interior western hemlock - western red cedar zone also occurs in various locations to the east of Moyie Lake including along the Yahk River, Little Van Creek, Lodgepole Creek and Sand Creek. These areas indicate local increases in precipitation which may be caused by storms converging in the Rocky Mountains (Chilton, personal communication).

Generally, seral stands are dominated by lodgepole pine and western hemlock. Varying amounts of

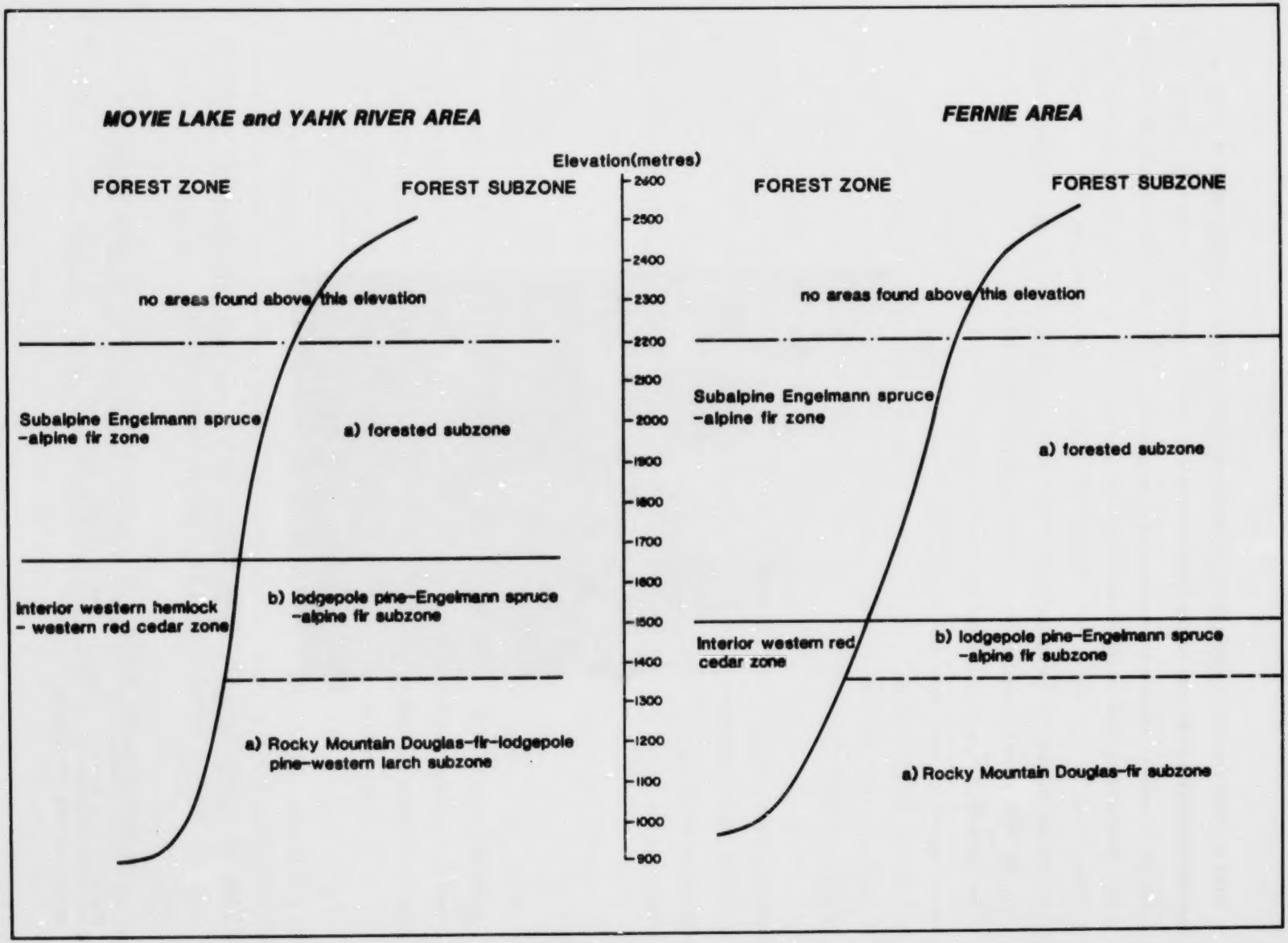

Figure 2.4 Forest Zonation of the Interior Wet Belt Region

Rocky Mountain Douglas-fir, western larch, western white pine, paper birch and trembling aspen may be mixed in seral stands. At higher elevations, alpine fir and Engelmann spruce may occur as seral species to western hemlock and western red cedar on cool, moist sites. Plate 2.9 illustrates the tree composition typical of this zone.

On steep, south to southwest facing slopes with coarse-textured soils, Rocky Mountain Douglas-fir may form edaphic climax stands. Lodgepole pine is the dominant seral species on these sites. The understory is usually dominated by birch-leaved spirea, soopolallie and pine grass.

Plate 2.9: A stand within the Interior western hemlock - western red cedar zone dominated by western hemlock, western white pine and alpine fir. The understory has thin-leaved mountain alder, blue-bead clintonia and unifoliate-leaved foamflower.

The Interior western hemlock - western red cedar zone consists of two subzones: the Rocky Mountain Douglas-fir - lodgepole pine - western larch subzone and the Lodgepole pine - Engelmann spruce - alpine fir subzone.

Rocky Mountain Douglas-fir - Lodgepole Pine - Western Larch Subzone

Seral stands of this subzone are usually dominated by lodgepole pine often mixed with western white pine, Rocky Mountain Douglas-fir, paper birch, western larch and western hemlock. Alpine fir and Engelmann spruce do not occur in this subzone. This subzone occurs between 1200 m to 1350 m. Succession in this subzone is relatively fast. Moisture deficiencies may occur at lower elevations, and under these conditions, poor regeneration of western hemlock and western red cedar may result in slow succession.

The understory of this subzone is generally dominated in the shrub layer by Oregon boxwood, western thimbleberry and birch-leaved spirea. The herb layer commonly consists of blue-bead clintonia, unifoliate-leaved foamflower and northern twinflower. A well developed moss layer is usually present.

The soils of this subzone are somewhat leached and moderately acidic. Medium to coarse-textured soils generally are classified as Orthic Dystric Brunisols and Orthic Humo-Ferric Podzols (Lacelle, in preparation). On finer textured soils a distinct clay enriched layer may develop in the subsoil (Luvisols). These finer textured soils are more fertile and generally have better moisture holding capacity in the rooting zone.

Lodgepole Pine - Engelmann Spruce - Alpine Fir Subzone

In this subzone, Engelmann spruce and alpine fir can occur as seral species. This subzone is located between 1350 m and 1650 m. Following fire or logging, seral stands usually consist of a mixture of alpine fir, western hemlock and western red cedar although lodgepole pine, western white pine and Engelmann spruce may be present. Once a tree cover affords a more protected environment, western hemlock and western red cedar are able to establish and dominate regeneration.

The understory shrubs of stands in this subzone consist of smooth Pacific menziesia, black blueberry and thin-leaved mountain alder. The herb layer is generally dominated by blue-bead clintonia, unfoliate-leaved foamflower and heart-leaved arnica. The moss layer is generally continuous and formed by common moss, feather moss and layered moss.

This subzone is cooler and receives more precipitation than the lower subzone. The soils are generally somewhat leached and acidic. Medium to coarse-textured soils are generally Humo-Ferric

Podzols. On finer textured soils (Luvisols), a distinct clay layer may exist which creates favourable moisture and nutrient availability in the rooting zone of plants.

2.2.2.2 INTERIOR WESTERN RED CEDAR ZONE

Western red cedar is the climatic climax species of this zone. In the East Kootenay study area, this zone is found only in the Elk River valley, south of Fernie, occurring from valley bottom to an elevation of about 1500 m. The soils of this zone are generally strongly calcareous throughout all soil horizons. These soils are favourable to western red cedar while limiting western hemlock establishment. Western hemlock is rarely found in this zone.

This zone has relatively high precipitation as is indicated by the climate data for Fernie (Table 2.1).

For most of the zone, seral stands consist of Rocky Mountain Douglas-fir, western larch and paper birch mixed with western red cedar. In receiving positions at lower elevations, white spruce may be present. At higher elevations, Engelmann spruce and alpine fir can occur in seral stands.

Within the Interior western red cedar zone two subzones occur: the Rocky Mountain Douglas-fir subzone and the Lodgepole pine - Engelmann spruce - alpine fir subzone.

Rocky Mountain Douglas-fir Subzone

Rocky Mountain Douglas-fir generally dominates seral stands in this subzone. Typically, Engelmann spruce and alpine fir are lacking as potential seral species. This subzone extends from valley bottom to approximately 1350 m on the mountain slopes. Rocky Mountain Douglas-fir, western larch and western red cedar are commonly found in seral stands while lesser amounts of white spruce and paper birch can occur.

The understory is dominated by a shrub layer of Oregon boxwood, western yew and western thimbleberry. Blue-bead clintonia, northern twinflower, oak fern and heart-leaved arnica are representative herbs. Forest stands dominated by western red cedar may be very dense and have a sparse understory.

The soils are generally quite calcareous. On medium to coarse-textured soils, Orthic Eutric Brunisols dominate (Lacelle, in preparation). On finer textured soils, a clay enriched layer may be present in the soil which creates more favourable nutrient and moisture availability in the rooting zone of plants. These soils are classified as Brunisolic Gray Luvisols.

Lodgepole Pine - Engelmann Spruce - Alpine Fir Subzone

Engelmann spruce and alpine fir can occur in this subzone. It extends from approximately 1350 m to 1500 m. This subzone has higher precipitation, a shorter growing season and colder winter temperatures than the lower subzone. Seral stands usually consist of a mixture of Engelmann spruce, alpine fir and western red cedar. Western larch may be present.

The understory of this subzone is dominated by smooth Pacific menziesia, black blueberry, bluebead clintonia, unifoliate-leaved foamflower and heart-leaved arnica. In areas of dense western red cedar cover the understory may be sparse.

The soils of this subzone are somewhat leached and acidic. Medium to coarse-textured soils are generally classified as Orthic Humo-Ferric Podzols (Lacelle, in preparation). On finer textured soils a distinct clay layer occurs in soil creating favourable moisture and nutrient availability in the rooting zone of the plants. These finer textured soils are generally classified as Podzolic Gray Luvisols.

2.2.2.3 SUBALPINE ENGELMANN SPRUCE - ALPINE FIR ZONE

The Subalpine Engelmann spruce - alpine fir zone extends from approximately 1500 m to 2300 m. Engelmann spruce and alpine fir are the climatic climax species for this zone. It is similar to the subalpine zone of the Dry Interior Region although it is generally subject to higher precipitation.

Within the East Kootenay study area one subzone, the Forested subzone, was designated. Further breakdown of this subzone was not possible because of limited sampling in this area.

Forested Subzone

Seral stands are dominated by lodgepole pine and western larch. This subzone extends from 1500 to 2300 m. Often alpine fir, Engelmann spruce and Rocky Mountain Douglas-fir are present in seral stands. This subzone has a limited areal extent within the East Kootenay study area.

The understory in this subzone is dominated by a shrub layer of smooth Pacific menziesia, black blueberry and white-flowered rhododendron. The herb layer consists of grouseberry, blue-bead clintonia and heart-leaved arnica. The moss layer is usually well developed and dominated by common moss, layered moss and feather moss.

The soils are quite leached and fairly acidic. Orthic Humo-Ferric Podzols are common on medium to coarse-textured materials while Podzolic Gray Luvisols are common on finer textured materials.

CHAPTER THREE

MAJOR SUCCESSIONAL[1] TRENDS FOR THE EAST KOOTENAY AREA

Succession is the progressive development of vegetation to a stable endpoint (climax) following a disturbance which has destroyed all or part of the existing vegetation without significantly altering the local climate and soils of the site (changes in microclimate may occur).

As a result of the frequent incidence of fires, widespread grazing and extensive logging, the East Kootenay landscape is dominated by a variety of seral vegetation. Succession will differ depending on climate, soils and historical development of the flora of an area. Understanding successional sequences over time, as they are related to landscape position, aids land managers in manipulating the vegetation cover to achieve their aims.

Succession will have different starting points and different pathways depending on time of disturbance, intensity of disturbance and specific variations in climatic events. However, although predictability of precise development of vegetation is in question, general trends can be identified. Such trends will identify how the vegetation can develop (with greater probability than other sequences).

3.1 SUCCESSIONAL SEQUENCES

The most common successional sequences are described for the more widely occurring kinds of sites of each subzone (Table 3.1 to 3.8). Wet sites which have successional sequences leading to edaphic climaxes are described for the Interior Rocky Mountain Douglas-fir zone in Table 3.4 and for the Engelmann spruce - alpine fir zone in Table 3.7. Because of limited information on successional trends for the Interior western hemlock - western red cedar zone, the Interior western red cedar zone and the krummholz subzone of the Subalpine Engelmann spruce - alpine fir zone only one sequence per subzone is described (Table 3.8). No successional trends are presented for the alpine tundra zone. Because of severe climatic conditions here, succession usually starts with re-establishment of pioneer vegetation (primary succession) while minor disturbances do not significantly alter the species composition present.

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[1] This chapter deals only with secondary succession. Primary succession, which refers to the development of vegetation on newly formed, previously unvegetated sites, is not discussed.

In the tables, the major successional sequences are grouped by moisture regime (dry, average and moist conditions) and habitat (terrain, landscape position and soil). The soil association components[2], on which a particular sequence may occur, are indicated. With the aid of the soils maps, these soil association components permit the user of this report to relate the succession sequences to the landscape (see Volume Two, Appendix B). A successional sequence found on the first component of a soil association (e.g. FE_1) may be found on any component of that soil association.

Dominant species which occur in each of the seral stages are listed for each succession sequence. Where possible, for a stage, the numbers of representative vegetation types are indicated in parentheses. These types are described in Volume Three of this report. The stage for which specific vegetation types are indicated are determined directly from the data, while the remaining stages are indirectly inferred from this study. A consecutive Succession Sequence Number is given to each sequence which is cross-referenced to the Vegetation Type Descriptions in Volume Three.

Different stages than those described for a sequence may occur as a result of variation in intensity and timing of disturbance, available seed source, microclimate, site conditions or other factors. Alternatively such different stages may represent specific points in the continuous time sequence. On the basis of the information available from this reconnaissance study it is rarely possible to determine which of the alternatives applies. Such questions can be resolved only with continued observation of a number of identical sites that have been subjected to different treatments under carefully controlled experimental conditions.

Regardless of this scientific consideration the importance of these successional sequences is that:

1 they identify significant trends in vegetation succession inferred from a large number of observations

2 they identify types of vegetative cover that can be grown on the appropriate parts of the landscape.

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[2] Soils of the study area are described and mapped in Biophysical Resources of the East Kootenay Area: Soils (Lacelle, in preparation).

TABLE 3.1 - TABLE 3.8 (page 40 - 53)

TABLE 3.1

SUCCESSIONAL TRENDS OF THE PONDEROSA PINE SUBZONE OF THE INTERIOR ROCKY MOUNTAIN DOUGLAS-FIR ZONE

Succession Sequence Number	Moisture Regime	Habitat	Successional Stage		
			Recent Disturbance	Young Seral	Maturing Seral
1	Dry	coarse-textured soils of level fluvial terraces in valley bottoms	-open grassland of needle-and-thread grass, shaggy fleabane and prairie koeleria (107)[1]	-shrub-grassland of common rabbitbrush, bluebunch wheat grass, shaggy fleabane and needle-and-thread grass (117)	-parkland forest of ponderosa pine, common rabbitbrush, bluebunch wheat grass and Idaho fescue
2				or -shrub-grassland vegetation of antelopebush, bluebunch wheat grass, needle-and-thread grass and prairie koeleria	-parkland forests of ponderosa pine, antelopebush, bluebunch wheat grass and prairie koeleria (98, 102, 101, 110)
3		fine-textured soils of level lacustrine terraces in valley bottoms	-shrub-grassland of common rabbitbrush, prairie sagebrush, prairie koeleria and needle grass (120)	-parkland or open forests of ponderosa pine, Rocky Mountain juniper, bluebunch wheat grass and prairie koeleria	-open forests of ponderosa pine, Rocky Mountain juniper, bluebunch wheat grass and Idaho fescue
4		south to southwest facing slopes with shallow veneer of soils over bedrock	-shrub-grassland of common saskatoon, needle grass and prairie sagebrush	-parkland to open forest of ponderosa pine, common saskatoon and needle grass (98)	-open forest of ponderosa pine, common saskatoon and bluebunch wheat grass (97)
5		south to southwest facing slopes with deep soils	-shrub-herb cover of common saskatoon, arrow-leaved balsamroot and drooping brome grass	-parkland to open forests of ponderosa pine, common saskatoon, common snowberry and arrow-leaved balsamroot (108)	-open forests of ponderosa pine, common saskatoon, common snowberry and bluebunch wheat grass
6	Average	medium to coarse-textured soils of gentle to moderately sloped areas	-shrub-grassland of antelopebush, bluebunch wheat grass and needle grass	-open forest of ponderosa pine, antelopebush and bluebunch wheat grass (102)	-open forest of ponderosa pine, Rocky Mountain Douglas-fir, antelopebush and bluebunch wheat grass (102, 96, 109)
7	Moist	non-exposed slopes, medium to coarse-textured soils	-shrub-grassland of common snowberry, bluebunch wheat grass and rough fescue	-open to closed forest of ponderosa pine, common snowberry, bluebunch wheat grass and rough fescue	-closed forest of ponderosa pine, Rocky Mountain Douglas-fir, common snowberry, rough fescue and pine grass (96, 103)

[1] Numbers in parentheses refer to vegetation types in which information on species and vegetative cover can be obtained from vegetation type descriptions in Volume Three.

[2] For a description of each soil association component see Lacelle (in preparation).

Overmature Seral	Climax	Comments	Major Soil Association Components[2]
-open forest of ponderosa pine, Rocky Mountain Douglas-fir, bluebunch wheat grass and Idaho fescue	-open forest of Rocky Mountain Douglas-fir with an understory of bluebunch wheat grass and Idaho fescue	-very slow rate of succession; severe moisture deficits; highly calcareous soils; high soil surface temperatures; severe disturbance causes a cover of needle-and-thread grass, drooping brome grass and low pussytoes (105, 107) or a cover of small western needle grass (104)	E1, F1, FX1, SA1
-open forests of ponderosa pine, Rocky Mountain Douglas-fir, antelopebush and bluebunch wheat grass	-open forest of Rocky Mountain Douglas-fir with an understory of bluebunch wheat grass	-slightly richer with less coarse-textured soils than above but similar in succession, drought and soils	E1, F1, FX1, SA1
-open forests of ponderosa pine, Rocky Mountain Douglas-fir, Rocky Mountain juniper, bluebunch wheat grass and Idaho fescue	-open forest of Rocky Mountain Douglas-fir with an understory of bluebunch wheat grass and Idaho fescue	-very slow rate of succession; severe moisture deficits; highly calcareous soils; fine texture of soils prevents percolation of moisture so that it easily evaporates	M1
-open forest of ponderosa pine, Rocky Mountain Douglas-fir and bluebunch wheat grass	-open forest of Rocky Mountain Douglas-fir with a shrub-bunch grass understory of common saskatoon and bluebunch wheat grass	-slow rate of succession, severe moisture deficits; severe disturbance may create a fair amount of unvegetated ground interspersed among common saskatoon, Rocky Mountain maple and prairie sagebrush	COL7, P5, RB5, WY5
-open to closed forests of ponderosa pine, Rocky Mountain Douglas-fir and bluebunch wheat grass	-open to closed forest of Rocky Mountain Douglas-fir with a grass dominated understory of bluebunch wheat grass and pine grass	-slow rate of succession; moisture deficits much of growing season; severe disturbance may create a persistent cover of Rocky Mountain maple, common saskatoon, snowbush ceanothus and bluebunch wheat grass (135). Clearing may create a cover of bluebunch wheat grass (110)	COL1, E1, FX1, M1, P1, RB5, SA1, WY1
-closed forest of Rocky Mountain Douglas-fir and bluebunch wheat grass	-closed forest of Rocky Mountain Douglas-fir with an understory dominated by bluebunch wheat grass (pine grass may be common)	-moderately slow rate of succession, tree species establish fairly easily without disturbance; severe disturbance may cause a cover of needle grass, drooping brome grass and low pussytoes to establish -pine grass may dominate understory in moister areas	COL1, E1, F1, FX2, K1, M1, P1, WY1
-closed forest of ponderosa pine, Rocky Mountain Douglas-fir, common snowberry and pine grass	-closed forest of Rocky Mountain Douglas-fir with an understory of common snowberry and pine grass	-relatively fast rate of succession; moisture deficits during the growing season limit regeneration and tree productivity; trembling aspen may be dominant in early stages particularly in receiving slope positions	COL1, E1, F1, FX1, K1, M1, SA1, WY1, SA10

TABLE 3.2

SUCCESSIONAL TRENDS OF THE WESTERN LARCH - PONDEROSA PINE SUBZONE OF THE INTERIOR POCKY MOUNTAIN DOUGLAS-FIR ZONE

Succession Sequence Number	Moisture Regime	Habitat	Successional Stage		
			Recent Disturbance	Young Seral	Maturing Seral
8	Dry	coarse-textured soils of level fluvial terraces in valley bottoms	-grassland vegetation with needle-and-thread grass, shaggy fleabane and prairie koeleria (107)[1]	-parkland to open forests of ponderosa pine, common rabbitbrush, bluebunch wheat grass, shaggy fleabane and needle-and-thread grass	-open forests of ponderosa pine, common rabbitbrush, bluebunch wheat grass and Idaho fescue
9		fine-textured soils of level, lacustrine terraces in valley bottoms	-shrub-grassland of common rabbitbrush, prairie koeleria and needle grass	-parkland to open forests of ponderosa pine, Rocky Mountain juniper, bluebunch wheat grass and prairie koeleria	-open forests of ponderosa pine, Rocky Mountain juniper, bluebunch wheat grass and Idaho fescue
10		south to southwest facing slopes; medium to coarse-textured soils	-shrub-grassland of common saskatoon, arrow-leaved balsamroot and bluebunch wheat grass	-open forests of ponderosa pine, common saskatoon, arrow-leaved balsamroot and bluebunch wheat grass (108)	-open forests of ponderosa pine, common saskatoon, bluebunch wheat grass and arrow-leaved balsamroot (108, 97, 109)
11	Average	medium to coarse-textured soils of gentle to moderately sloping areas	-shrub-grassland of soopolallie, pine grass and kinnikinnick	-closed forests of ponderosa pine, western larch, soopolallie, pine grass and kinnikinnick (89, 91, 96)	-closed forests of western larch, ponderosa pine, soopolallie, pine grass and kinnikinnick (89)
12	Moist	medium to fine-textured soils on non-exposed slopes	-shrub-grassland of common snowberry and pine grass	-closed forests of western larch, common snowberry, birch-leaved spirea and pine grass (89)	-closed forests of western larch, Rocky Mountain Douglas-fir, birch-leaved spirea, pine grass and showy aster

[1] Numbers in parentheses refer to vegetation types in which information on species and vegetative cover can be obtained from vegetation type descriptions in Volume Three.

[2] For a description of each soil association component see Lacelle (in preparation).

Overmature Seral	Climax	Comments	Major Soil Association Components[2]
-open forest of ponderosa pine, Rocky Mountain Douglas-fir, bluebunch wheat grass and Idaho fescue	-open to closed forests of Rocky Mountain Douglas-fir with an understory of bluebunch wheat grass and Idaho fescue	-very slow rate of succession; severe moisture deficits; highly calcareous soils; severe disturbance causes vegetation to be dominated by needle-and-thread grass, drooping brome and low pussytoes (105); antelopebush may dominate in early stages	E1, F1, FX1, SA1
-open forests of ponderosa pine, Rocky Mountain Douglas-fir, bluebunch wheat grass and Idaho fescue	-open to closed forests of Rocky Mountain Douglas-fir with a bunch grass understory of bluebunch wheat grass and Idaho fescue	-very slow rate of succession; severe moisture deficits; highly calcareous soils; severe disturbances causes vegetation to be dominated by prairie sagebrush and needle grass	M1
-open forests of ponderosa pine, Rocky Mountain Douglas-fir, common saskatoon and bluebunch wheat grass	-open to closed forests of Rocky Mountain Douglas-fir with an understory of bluebunch wheat grass	-slow rate of succession; severe moisture deficits particularly on coarse-textured soils; severe disturbance may cause a cover of Rocky Mountain maple, common saskatoon, snowbush ceanothus and bluebunch wheat grass (135) to occur	COL1, E1, FX1, P1, WY1
-closed forests of western larch, Rocky Mountain Douglas-fir, birch-leaved spirea, pine grass and kinnikinnick (82, 83, 85, 88, 100)	-closed forests of Rocky Mountain Douglas-fir with an understory of birch-leaved spirea and pine grass	-moderate rate of succession with fairly good tree regeneration and tree productivity; moisture deficits part of growing season	COL1, E1, F1, FX1, K1, M1, WY1
-closed forests of Rocky Mountain Douglas-fir, western larch, birch-leaved spirea, pine grass and showy aster	-closed forests of Rocky Mountain Douglas-fir with an understory of birch-leaved spirea, pine grass and showy aster (81)	-relatively fast succession with fairly good tree regeneration and tree productivity; moisture deficits part of growing season; lodgepole pine may dominate as seral tree	E1, FX1, K1, M1, WY1

TABLE 3.3

SUCCESSIONAL TRENDS OF THE LODGEPOLE PINE SUBZONE OF THE INTERIOR ROCKY MOUNTAIN DOUGLAS-FIR ZONE

Succession Sequence Number	Moisture Regime	Habitat	Successional Stage		
			Recent Disturbance	Young Seral	Maturing Seral
13	Dry	coarse-textured soils of level fluvial terraces in valley bottom areas or morainal material	-shrub-herb cover of soopolallie, pine grass and fireweed	-closed forests of lodgepole pine, soopolallie, pine grass and dwarf blueberry (41, 57, 59, 79, 91, 61, 66)[1]	-closed forests of lodgepole pine, soopolallie, pine grass and dwarf blueberry (41, 57, 59, 79, 91)
14			-shrub-herb cover of common rabbitbrush, prairie sagebrush and prairie koeleria	-open forests of Rocky Mountain Douglas-fir, common rabbitbrush, prairie sagebrush and prairie koeleria	-open forests of Rocky Mountain Douglas-fir, common rabbitbrush, bluebunch wheat grass and prairie koeleria (119)
15		fine-textured soils of level lacustrine terraces in valley bottom areas	-shrub-herb cover of Rocky Mountain juniper, common saskatoon and needle grass	-broad-leaved forests of trembling aspen, common saskatoon and needle grass	-mixed forests of trembling aspen, Rocky Mountain Douglas-fir, common saskatoon and pine grass (43)
16			-shrub-herb cover of common rabbitbrush, prairie sagebrush and prairie koeleria	-open forests of Rocky Mountain Douglas-fir, common rabbitbrush, prairie sagebrush and prairie koeleria	-open forests of Rocky Mountain Douglas-fir, common rabbitbrush, bluebunch wheat grass and prairie koeleria
17		south to southwest facing slopes of medium to coarse-textured soils with deep to shallow soils	-shrub-herb cover of choke cherry, bluebunch wheat grass and round-leaved alumroot	-open forests of Rocky Mountain Douglas-fir, common saskatoon, choke cherry, bluebunch wheat grass and round-leaved alumroot	-open forests of Rocky Mountain Douglas-fir, common saskatoon and bluebunch wheat grass (97)
18	Average	medium to coarse-textured soils of gentle to moderately sloped areas of middle to lower slope positions	-shrub-herb cover of common juniper, pine grass and kinnikinnick	-closed forest of lodgepole pine, common juniper, pine grass and kinnikinnick	-closed forest of lodgepole pine, common juniper, pine grass and kinnikinnick (78, 80)
19			-shrub-herb cover of soopolallie, pine grass and fireweed	-closed forest of lodgepole pine, soopolallie, pine grass and kinnikinnick	-closed forest of lodgepole pine, soopolallie, pine grass and kinnikinnick (79, 94)
20		medium to coarse-textured soils of gentle to moderately sloped areas of middle to lower slope positions	-shrub-herb cover of birch-leaved spirea, pine grass and fireweed	-closed forests of lodgepole pine, soopolallie, birch-leaved spirea, pine grass and kinnikinnick (42, 87)	-closed forests of lodgepole pine, birch-leaved spirea, pine grass and heart-leaved arnica (63, 66, 93, 62, 83)
21	Moist	non-exposed aspects and/or sites at higher elevations within the subzone and/or finer textured soils	-shrub-herb cover of birch-leaved spirea, fireweed and pine grass	-closed forests of lodgepole pine, birch-leaved spirea, Canadian bunchberry and pine grass (61, 66)	-closed forests of lodgepole pine, Rocky Mountain Douglas-fir, birch-leaved spirea, Canadian bunchberry and pine grass (61, 66)
22			-herb dominated cover of fireweed, pine grass and western meadow-rue	-closed forests of lodgepole pine, pine grass, Canadian bunchberry and western meadow-rue	-closed forests of lodgepole pine, Rocky Mountain Douglas-fir, pine grass, Canadian bunchberry and western meadow-rue

[1] Numbers in parentheses refer to vegetation types in which information on species and vegetative cover can be obtained from vegetation type descriptions in Volume Three.

[2] For a description of each soil association component see Lacelle (in preparation).

Overmature Seral	Climax	Comments	Major Soil Association Components[2]
-closed forests of lodgepole pine, Rocky Mountain Douglas-fir, soopolallie, pine grass and dwarf blueberry	-closed forests of Rocky Mountain Douglas-fir with an understory of pine grass and dwarf blueberry	-slow rate of succession; sensitive to disturbance because of low moisture availability, low nutrient status and little organic buildup; common juniper frequently occurs in seral stages	GM1, KE1, MA1
-open to closed forests of Rocky Mountain Douglas-fir, bluebunch wheat grass and prairie koeleria	-open to closed forests of Rocky Mountain Douglas-fir with an understory of bluebunch wheat grass and prairie koeleria	-slow rate of succession due to cool, dry climate with severe moisture deficits; occurs in Rocky Mountain Trench, north of Columbia Lake	GM1, KE1, MD1
-closed forests of Rocky Mountain Douglas-fir, common saskatoon and pine grass	-closed forests of Rocky Mountain Douglas-fir with an understory of common snowberry and pine grass	-slow rate of succession due to moisture deficits; soil holds moisture at surface where it is subject to evaporation	AZ1, MD1
-open to closed forests of Rocky Mountain Douglas-fir, bluebunch wheat grass and prairie koeleria	-open to closed forests of Rocky Mountain Douglas-fir with an understory of pine grass and bluebunch wheat grass	-slow rate of succession due to moisture deficits; occurs most commonly north of Columbia Lake in the Rocky Mountain Trench	AZ1
-open to closed forests of Rocky Mountain Douglas-fir, common saskatoon, pine grass and bluebunch wheat grass	-open to closed forests of Rocky Mountain Douglas-fir, common saskatoon, pine grass and bluebunch wheat grass (84)	-slow rate of succession due to severe moisture deficits which are greater on areas with shallow or coarse-textured soils; rough fescue may be common at higher elevations; severe disturbance may cause a cover of common saskatoon, choke cherry, snowbush ceanothus and bluebunch wheat grass to persist	BF5, CA11, CG7, CLD1, CR1, FL1, RY5, GM1, KE1, MD1, MS1, RY5
-closed forest of lodgepole pine, Rocky Mountain Douglas-fir, common juniper, pine grass and kinnikinnick (105)	-closed forest of Rocky Mountain Douglas-fir with an understory of common juniper, a continuous cover of pine grass, and kinnikinnick	-moderate moisture deficits through much of summer; moderate rate of succession	BF1, CA11, CLD1, CR1, FL1, GM1, KE1, MD1, MS1
-closed forest of Rocky Mountain Douglas-fir, lodgepole pine, birch-leaved spirea, pine grass and kinnikinnick (79, 85)	-closed forests of Rocky Mountain Douglas-fir with an understory of birch-leaved spirea, kinnikinnick and a continuous cover of pine grass	-some moisture deficits through part of the summer -moderate rate of succession	AZ1, CA11, CLD1, CR1, FL1, GM1, KE1, MA1, MD1, MY1, RS1
-closed forests of Rocky Mountain Douglas-fir, lodgepole pine, birch-leaved spirea, pine grass and heart-leaved arnica (88)	-closed forests of Rocky Mountain Douglas-fir with an understory of birch-leaved spirea, heart-leaved arnica and a continuous cover of pine grass (81, 86)	-some moisture deficits through part of the summer -moderate rate of succession	AZ1, CA11, CD1, CLD1, CR1, FL1, GM1, KE1, MA1, MD1, MS1, MZ1
-closed forests of Rocky Mountain Douglas-fir, lodgepole pine, birch-leaved spirea, Canadian bunchberry and mosses	-closed forests of Rocky Mountain Douglas-fir with an understory of Canadian bunchberry and a continuous moss layer	-higher elevations of the subzone; relatively more acidic soils; relatively fast rate of succession	AZ1, CA11, CC4, CD1, CLD1, CO4, CR1, FL1, GM1, KE4, MA1, MD1, MS5
-closed forests of Rocky Mountain Douglas-fir, lodgepole pine, Canadian bunchberry and moss	-closed forests of Rocky Mountain Douglas-fir with an understory of Canadian bunchberry and a continuous moss layer	-relatively rich nutrient status and warm, moist climatic conditions	AZ1, CA11, CLD1, CR1, FL1, MD1

TABLE 3.4

SUCCESSIONAL TRENDS OF WET, EDAPHIC CLIMAX VEGETATION IN VALLEY BOTTOM AREAS OF THE INTERIOR ROCKY MOUNTAIN DOUGLAS-FIR ZONE

Succession Sequence Number	Habitat	Successional Stage		
		Recent Disturbance	Young Seral	Maturing Seral
23	low floodplain which is subjected to frequent flooding	-shrub dominated cover of western red-osier dogwood and willows with star-flowered false Solomon's-seal	-broad-leaved forest of trembling aspen, western red-osier dogwood and star-flowered false Solomon's-seal (71)[1]	-broad-leaved forest of trembling aspen, black cottonwood, western red-osier dogwood and star-flowered false Solomon's-seal
24		-shrub dominated cover of western red-osier dogwood and willows with star-flowered false Solomon's-seal	-broad-leaved forest of black cottonwood, western red-osier dogwood and star-flowered false Solomon's-seal	-broad-leaved forests of black cottonwood, western red-osier dogwood and star-flowered false Solomon's-seal
25	floodplain which is subjected to occasional flooding	-shrub dominated cover of western red-osier dogwood, high bush cranberry and palmate colt's-foot	-broad-leaved forests of black cottonwood, western red-osier dogwood and wild rye grass	-broad-leaved forests of black cottonwood, western red-osier dogwood and wild rye grass (68)
26	floodplain or low terraces with infrequent flooding	-shrub-herb cover of willow, common horsetail and palmate colt's-foot	-broad-leaved forests of black cottonwood, willow, common horsetail and palmate colt's-foot	-mixed forests of black cottonwood, white spruce, common horsetail and palmate colt's-foot
27		-shrub-herb cover of twin-berry honeysuckle, willow and wild rye grass	-closed forests of lodge-pole pine, twinberry honeysuckle, baldhip rose and wild rye grass	-closed forests of lodgepole pine, white spruce, baldhip rose and wild rye grass (114)
28	receiving slope positions in valley bottom, nutrient rich, moist sites	-shrub-herb cover of common snowberry, Canadian bunch-berry and fireweed	-broad-leaved forests of trembling aspen, common snowberry, wild rye grass and Canadian bunchberry (74)	-mixed forests of trembling aspen, white spruce, common snowberry and Canadian bunchberry (77, 95)
29		-shrub-herb cover of thimbleberry, wild rye grass and fireweed	-closed forests of Rocky Mountain Douglas-fir, western thimbleberry and sweet-scented bedstraw	-closed forests of Rocky Mountain Douglas-fir, western red cedar, western thimbleberry and sweet-scented bedstraw (69)

[1] Numbers in parentheses refer to vegetation types in which information on species and vegetative cover can be obtained from vegetation type descriptions in Volume Three.

[2] For a description of each soil association component see Lacelle (in preparation).

Overmature Seral	Climax	Comments	Major Soil Association Components[2]
-broad-leaved forests of black cottonwood, western red-osier dogwood, star-flowered false Solomon's-seal and sweet-scented bedstraw	-broad-leaved forests of black cottonwood with a dense shrub understory of western red-osier dogwood and a sparse herb layer dominated by sweet-scented bedstraw	-calcareous soils; highly variable water table; generally a dense shrub layer and sparse herb layer; severe disturbance creates a cover dominated by willow and yellow mountain-avens	CN_{10}, CN_{11}, FF_{10}, FF_{11}, FS_{10}, FS_{11}, KO_{11}, L_{11}, S_{10}, S_{11}
-broad-leaved forests of black cottonwood, western red-osier dogwood, star-flowered false Solomon's-seal and sweet-scented bedstraw	-broad-leaved forests of black cottonwood with a dense shrub understory of western red-osier dogwood and a sparse herb layer dominated by sweet-scented bedstraw	-less calcareous soils than above; high water table; recently deposited soil; generally a dense shrub layer and sparse herb layer; severe disturbance creates a cover dominated by willow and yellow mountain-avens	CN_{10}, CN_{11}, FF_{10}, FF_{11}, FS_{10}, FS_{11}, KO_{11}, L_{11}, S_{10}, S_{11}
-mixed forests of black cottonwood, white spruce, western red-osier dogwood and wild rye grass	-mixed forests of white spruce, black cottonwood, western red-osier dogwood and wild rye grass (70)	-moderately high water table and good surface drainage allows a mixture of spruce and cottonwood to form the climax	AZ_2, CN_1, CN_3, FF_1, FF_3, FS_1, FS_3, GM_{10}, S_1, S_2, S_3
-mixed forests of white spruce, black cottonwood, common horsetail, arctic colt's-foot and moss	-closed forests of white spruce with an understory of palmate coltsfoot and a continuous cover of common horsetail and moss (113)	-high water table; poor drainage and poor soil aeration at the surface; shrub layer may be dominated by black swamp gooseberry in later stages; in pioneer stages this area may have a cover of western birch and creek goldenrod (125)	CN_1, FF_1, FS_1, GM_{10}, KO_{10}, L_{10}, S_2
-closed forests of white spruce, lodgepole pine, Saskatoon, prickly rose and wild rye grass	-closed forests of white spruce with a dense understory cover of shrubs dominated by Saskatoon, prickly rose and wild rye grass	-deeper water table than above, soils slightly acidic	CN_1, FF_1, FS_1, GM_{10}, KO_{10}, L_{10}, S_2
-mixed forests of white spruce, trembling aspen, common snowberry and Canadian bunchberry	-closed forests of white spruce with a dense shrub cover of common snowberry and herb cover dominated by northern bedstraw	-relatively deep water table; soils are neutral to slightly acidic; frequently associated with silty-textured soils	AZ_1, CAI_1, CLD_1, COL_1, CR_1, FL_1, M_1, RA_1, MD_1, WY_1
-closed forests of western red cedar, Rocky Mountain Douglas-fir, western thimbleberry and oak fern	-closed forests of western red cedar with an understory of western thimbleberry, oak fern and mosses (68)	-rich, calcareous soils; often in narrow valleys; understory of climax stands may be sparse due to dense forest cover of cedar	AZ_1, CAI_1, CLD_1, COL_1, CR_1, FL_1, M_1, RA_1, MD_1, WY_1

TABLE 3.5

SUCCESSIONAL TRENDS OF THE ROCKY MOUNTAIN DOUGLAS-FIR - LODGEPOLE PINE SUBZONE OF THE SUBALPINE ENGELMANN SPRUCE - ALPINE FIR ZONE

Succession Sequence Number	Moisture Regime	Habitat	Successional Stage		
			Recent Disturbance	Young Seral	Maturing Seral
30	Dry	coarse-textured soils of level fluvial terraces	-shrub-herb cover of soopolallie, fireweed and pine grass	-closed forests of lodgepole pine, soopolallie, pine grass and dwarf blueberry (41, 57, 55, 58, 61, 66)[1]	-closed forests of lodgepole pine, soopolallie, pine grass and dwarf blueberry (41, 62, 56, 59, 65)
31		south to southwest facing slopes with medium to coarse-textured shallow to deep soils	-shrub-herb cover of soopolallie, birch-leaved spirea, rough fescue, pine grass and fireweed	-open forests of Rocky Mountain Douglas-fir, birch-leaved spirea, soopolallie, rough fescue and pine grass or	-open forests of Rocky Mountain Douglas-fir, birch-leaved spirea, pine grass and rough fescue
32				-open forests of lodgepole pine, birch-leaved spirea, soopolallie, pine grass and rough fescue	-open forests of lodgepole pine, Rocky Mountain Douglas-fir, birch-leaved spirea and pine grass (60)
33	Average	medium to coarse-textured soils; moderate slopes; lower elevations of subzone	-shrub-herb cover of birch-leaved spirea and fireweed	-closed forests of lodgepole pine, Rocky Mountain Douglas-fir, birch-leaved spirea, pine grass and fireweed (40, 48, 63, 50, 51)	-closed forests of lodgepole pine, Rocky Mountain Douglas-fir, alpine fir, birch-leaved spirea and pine grass (46, 48, 53, 63, 45, 52)
34		medium to coarse-textured soils; steep slopes; higher elevations of subzone	-shrub-herb cover of willow, birch-leaved spirea, grouseberry and fireweed	-closed forests of Rocky Mountain Douglas-fir, lodgepole pine, birch-leaved spirea, grouseberry and heart-leaved arnica	-closed forests of Rocky Mountain Douglas-fir, lodgepole pine, alpine fir, smooth Pacific menziesia, birch-leaved spirea and grouseberry
35		medium to coarse-textured soils; moderate slopes; non-exposed aspects	-shrub-herb cover of smooth Pacific menziesia, heart-leaved arnica and fireweed	-closed forests of Rocky Mountain Douglas-fir, lodgepole pine, smooth Pacific menziesia and heart-leaved arnica	-closed forests of Rocky Mountain Douglas-fir, alpine fir, smooth Pacific menziesia, heart-leaved arnica and mosses (28)
36	Moist	receiving slope positions in valley bottoms or level areas	-shrub-herb cover of soopolallie, Canadian bunchberry, stiff club-moss and fireweed	-closed forests of lodgepole pine, soopolallie, Canadian bunchberry and stiff club-moss	-closed forests of lodgepole pine, Engelmann spruce, Utah honeysuckle, Canadian bunchberry, stiff club-moss and mosses (64)
37		receiving slope positions in valley bottom	-shrub-herb cover of western thimbleberry, western meadow-rue and fireweed (121)	-closed forests of lodgepole pine, western thimbleberry, western meadow-rue, unifoliate-leaved foamflower	-closed forests of lodgepole pine, Engelmann spruce, western thimbleberry, western meadow-rue and unifoliate-leaved foamflower

[1] Numbers in parentheses refer to vegetation types in which information on species and vegetative cover can be obtained from vegetation type descriptions in Volume Three.

[2] For a description of each soil association component see Lacelle (in preparation).

Overmature Seral	Climax	Comments	Major Soil Association Components[2]
-closed forests of lodgepole pine, Engelmann spruce, alpine fir, smooth Pacific menziesia, dwarf blueberry and mosses	-closed forests of alpine fir and Engelmann spruce with an understory dominated by smooth Pacific menziesia, northern twinflower and moss	-slow rate of succession; low nutrient and moisture availability because of rapid drainage	GB_1, GU_1, GT_1
-closed forests of Rocky Mountain Douglas-fir, alpine fir, birch-leaved spirea and pine grass	-closed forests of alpine fir, Engelmann spruce, birch-leaved spirea, pine grass and moss	-slow rate of succession; moisture deficiencies and high surface temperatures may inhibit tree establishment; severe disturbance causes a cover of trembling aspen, soopolallie, common saskatoon and rough fescue (90, 92, 43) to persist	BS_5, BS_7, CJ_1, CW_1, GT_1, MM_1, RM_5, RR_6, SP_1
-open forests of Rocky Mountain Douglas-fir, lodgepole pine, birch-leaved spirea and pine grass (85)	-open to closed, edaphic climax forests of Rocky Mountain Douglas-fir with an understory of birch-leaved spirea and pine grass	-slow rate of succession; severe moisture deficiencies and high surface temperatures; severe disturbance cause a cover of trembling aspen, soopolallie, common saskatoon and rough fescue (90, 92) to persist	BS_5, BS_7, GB_1, MM_1, RM_5, RR_6
-closed forests of alpine fir, Rocky Mountain Douglas-fir, birch-leaved spirea and pine grass	-closed forests of alpine fir and Engelmann spruce with an understory of birch-leaved spirea and a continuous cover of moss with some pine grass	-moderate rate of succession; some moisture deficiency for part of growing season; western larch may dominate seral stages on finer-textured soils	CB_1, CW_1, GB_1, GD_1, LN_1, MM_1, MD_4, MT_1, MU_1, SP_1
-closed forests of alpine fir, Rocky Mountain Douglas-fir, smooth Pacific menziesia, grouseberry and mosses (30)	-closed forests of alpine fir and Engelmann spruce with an understory of smooth Pacific menziesia, a continuous cover of grouseberry and mosses	-relatively good moisture availability allows good tree regeneration and fairly fast rate of succession	CW_1, GB_3, MM_1, SP_1
-closed forests of alpine fir, Rocky Mountain Douglas-fir, smooth Pacific menziesia, heart-leaved arnica and mosses	-closed forests of alpine fir and Engelmann spruce, with a dense shrub cover of smooth Pacific menziesia, heart-leaved arnica and a continuous moss layer	-good moisture availability allows good tree regeneration and fairly fast rate of succession	CW1, GB1, MM1, SP1
-closed forests of Engelmann spruce, lodgepole pine, Utah honeysuckle, stiff club-moss and mosses	-closed forests of Engelmann spruce and alpine fir with an understory of Utah honeysuckle, stiff club-moss and a continuous moss layer	-good moisture availability with moderately well-drained soils	CW_1, FF_2, GB_1, LN_1, MM_1, SP_1
-closed forests of Engelmann spruce, lodgepole pine, twinberry honeysuckle, unifoliate-leaved foamflower and mosses	-closed forests of Engelmann spruce and alpine fir with an understory of twinberry honeysuckle, unifoliate-leaved foamflower and mosses	-good moisture availability with relatively fast rate of succession; western red cedar may be present -may have a cover of willow, twinberry honeysuckle and wild rye grass (73) after severe disturbance	CW_1, GB_1, LN_1, MM_1

TABLE 3.6
SUCCESSIONAL TRENDS OF THE LODGEPOLE PINE - WHITEBARK PINE SUBZONE OF THE SUBALPINE ENGELMANN SPRUCE - ALPINE FIR ZONE

Succession Sequence Number	Moisture Regime	Habitat	Successional Stage		
			Recent Disturbance	Young Seral	Maturing Seral
38	Dry	coarse-textured soils on level fluvial terraces	-shrub-herb cover of soopolallie, pine grass and fireweed	-closed forests of lodgepole pine, soopolallie, pine grass and dwarf blueberry (41, 57)[1]	-closed forests of lodgepole pine, soopolallie, pine grass and dwarf blueberry (41, 62)
39		south to southwest facing slopes at lower elevations of this subzone	-shrub-herb cover of soopolallie, rough fescue and fireweed	-open forests of whitebark pine, soopolallie, rough fescue and sulphur hedysarum	-open forests of whitebark pine, soopolallie, rough fescue and sulphur hedysarum
40		south to southwest facing slopes at higher elevations of this subzone	-herb dominated cover of grouseberry and fireweed	-open forests of whitebark pine, soopolallie and grouseberry	-open forests of whitebark pine, soopolallie and grouseberry
41		steep slopes of various elevations and aspects which have rapid drainage or runoff	-shrub-herb cover of common juniper, grouseberry and fireweed	-open forests of lodgepole pine, abundant grouseberry and fireweed (19)	-open forests of lodgepole pine, abundant grouseberry and northern twinflower
42	Average	various elevations with gentle to moderate slopes with medium to coarse-textured soils	-herb dominated cover of grouseberry, northern twinflower and fireweed	-closed forests of lodgepole pine, smooth Pacific menziesia, grouseberry and fireweed (15, 22)	-closed forests of lodgepole pine, alpine fir, smooth Pacific menziesia, grouseberry and Canadian bunchberry (32, 25, 31)
43		lower elevations of this subzone; medium to coarse-textured soils	-shrub-herb cover of birch-leaved spirea, grouseberry, asters and fireweed	-closed forests of lodgepole pine, birch-leaved spirea, grouseberry and fireweed (35, 16, 21)	-closed forests of lodgepole pine, alpine fir, birch-leaved spirea, smooth Pacific menziesia and grouseberry (26, 29)
44	Moist	higher elevations; generally on non-exposed aspects with favourable moisture status	-shrub-herb cover of blue elder, western meadow-rue and fireweed	-closed forests of lodgepole pine, white-flowered rhododendron, grouseberry and western meadow-rue	-closed forests of lodgepole pine, alpine fir, white-flowered rhododendron, grouseberry and mosses
45		valley bottom areas; receiving slope positions	-shrub-herb cover of black swamp gooseberry, wild rye grass and fireweed	-closed forests of lodgepole pine, black swamp gooseberry, wild rye grass and fireweed (18)	-closed forests of lodgepole pine, Engelmann spruce, black swamp gooseberry and wild rye grass

[1] Numbers in parentheses refer to vegetation types in which information on species and vegetative cover can be obtained from vegetation type descriptions in Volume Three.

[2] For a description of each soil association component see Lacelle (in preparation).

Overmature Seral	Climax	Comments	Major Soil Association Components[2]
-closed forests of lodgepole pine, Engelmann spruce, alpine fir, smooth Pacific menziesia, dwarf blueberry and mosses	-closed forests of alpine fir and Engelmann spruce with an understory of smooth Pacific menziesia, northern twinflower and mosses	-slow rate of succession due to poor nutrient status and low moisture availability; litter buildup is slow and is easily destroyed by disturbance	GC_1, GL_1, KG_1
-open to closed forests of whitebark pine, alpine fir, smooth Pacific menziesia and pine grass	-closed forests of alpine fir and Engelmann spruce with an understory of smooth Pacific menziesia, northern twinflower and mosses	-slow rate of succession due to moisture deficiencies and high surface temperatures caused by sun exposure; severe disturbance may cause a cover of trembling aspen, soopolallie and rough fescue (90, 92) to persist	CM_1, CY_2, KG_1, MC_1, MX_1, RM_7
-open to closed forests of whitebark pine, alpine fir, smooth Pacific menziesia, grouseberry and mosses	-closed forests of alpine fir and Engelmann spruce with an understory of smooth Pacific menziesia, a continuous cover of grouseberry and mosses	-slow rate of succession; moisture deficiencies due to sun exposure and rapid runoff; severe disturbance may cause a cover of soopolallie, rough fescue and wild strawberry (90) to persist	CM_1, KG_1, MC_1, MX_1, RM_7
-open to closed forests of lodgepole pine, alpine fir, smooth Pacific menziesia, abundant grouseberry and northern twinflower (9, 10)	-closed forests of alpine fir and Engelmann spruce with an understory of smooth Pacific menziesia, a continuous layer of grouseberry, and common moss	-slow rate of succession due to moisture deficiencies caused by rapid runoff; the moss layer may be sparse in early stages	CI_1, CM_1, CS_4, CY_1, GC_2, MC_1, ME_2, MM_1, MR_4, MX_1, RG_5, RT_5
-closed forests of alpine fir, lodgepole pine, smooth Pacific menziesia, grouseberry and mosses (12, 11)	-closed forests of alpine fir and Engelmann spruce with a dense shrub layer of smooth Pacific menziesia, grouseberry and a continuous cover of mosses (24)	-abundant regeneration of climax species creating a relatively fast rate of succession; good moisture availability; mildly acidic soils	CH_2, CI_4, CM_1, CU_2, CS_1, CY_1, GC_2, GL_1, KG_1, MC_1, ME_1, MG_1, MM_1, MR_4, MX_1, MG_5, RT_3
-closed forests of alpine fir, lodgepole pine, smooth Pacific menziesia, grouseberry and mosses (26, 23)	-closed forests of alpine fir and Engelmann spruce with a dense shrub layer of smooth Pacific menziesia, grouseberry and a continuous moss cover (14)	-abundant regeneration of climax species; relatively fast rate of succession; good moisture availability; severe disturbance may cause thin-leaved mountain alder to persist	CM_1, CI_1, CM_1, CS_2, CY_4, CY_8, GC_2, KG_1, LL_1, MC_1, ME_1, ML_2, ML_4 MM_1, MX_1, SM_2, SN_4
-closed forests of alpine fir, lodgepole pine, white-flowered rhododendron and mosses (30)	-closed forests of alpine fir and Engelmann spruce with a dense shrub layer of white-flowered rhododendron, smooth Pacific menziesia and a continuous moss layer	-cool, moist sites of north to east aspects; acidic soils with generally favourble nutrient status because of a well formed litter layer; thin-leaved mountain alder may dominate early stages; deep snow accumulation	CH_2, CI_1, CM_1, CM_3, CY_1, CY_3, KG_1, MC_1, MM_4, MX_1, MX_3
-closed forests of Engelmann spruce, lodgepole pine, black swamp gooseberry and mosses	-closed forests of alpine fir and Engelmann spruce with an understory of black swamp gooseberry, Canadian bunchberry and a continuous moss cover	-favourable moisture and nutrient status; soils are well to moderately well drained	KG_1, LL_1, MC_1, MG_2, MM_1, MX_1

TABLE 3.7

SUCCESSIONAL TRENDS OF WET, EDAPHIC CLIMAX VEGETATION IN VALLEY BOTTOM AREAS OF THE SUBALPINE ENGELMANN SPRUCE - ALPINE FIR ZONE

Succession Sequence Number	Habitat	Successional Stage		
		Recent Disturbance	Young Seral	Maturing Seral
46	level floodplain with frequent flooding; usually coarse-textured soils	-shrub dominated cover of willows, western red-osier dogwood and star-flowered false Solomon's-seal	-broad-leaved forests of black cottonwood, willows, western red-osier dogwood and star-flowered false Solomon's-seal	-broad-leaved forests of black cottonwood, western red-osier dogwood and sweet-scented bedstraw
47	level floodplain with occasional flooding; medium to coarse-textured soils	-shrub dominated cover of willows, western red-osier dogwood and star-flowered false Solomon's-seal	-broad-leaved forests of black cottonwood, western red-osier dogwood and star-flowered false Solomon's-seal	-broad-leaved forests of black cottonwood, western red-osier dogwood and wild rye grass
48	floodplain with infrequent flooding	-shrub-herb cover of willow, common horsetail and palmate colt's-foot	-broad-leaved forests of black cottonwood, willow, common horsetail and palmate colt's-foot	-mixed forests of black cottonwood, Engelmann spruce, common horsetail and palmate colt's-foot
49	receiving slope positions in valley floor; moisture and nutrient rich sites; fine to medium-textured soils	-shrub-herb cover of common snowberry, Canadian bunchberry and fireweed	-broad-leaved forests of trembling aspen, common snowberry, wild rye grass and Canadian bunchberry	-mixed forests of trembling aspen, Engelmann spruce, common snowberry and Canadian bunchberry

[1] Number in parentheses refer to vegetation types in which information on species and vegetative cover can be obtained from vegetation type descriptions in Volume Three.

[2] For a description of each soil association component see Lacelle (in preparation).

TABLE 3.8

GENERALI SUCCESSIONAL TRENDS OF THE INTERIOR WESTERN HEMLOCK - WESTERN RED CEDAR ZONE, THE INTERIOR WESTERN RED CEDAR ZONE AND THE KRUMMHOLZ SUBZONE OF THE SUBALPINE ENGELMANN SPRUCE - ALPINE FIR ZONE OF THE DRY INTERIOR REGION

Succession Sequence Number	Zone	Subzone	Successional Stage	
			Recent Disturbance	Young Seral
50	Interior western hemlock - western red cedar zone	Rocky Mountain Douglas-fir - lodgepole pine - western larch subzone	-shrub-herb cover of western thimbleberry, western bracken, northern twinflower and fireweed	-closed forests of lodgepole pine, Oregon boxwood, western thimbleberry, northern twinflower and showy aster (44)[2]
51		Lodgepole pine - Engelmann spruce - alpine fir subzone	-shrub-herb cover of black blueberry, oak fern and fireweed	-closed forests of alpine fir, black blueberry, oak fern and mosses
52	Interior western red cedar zone	Rocky Mountain Douglas-fir subzone	-shrub-herb cover of western thimbleberry, oak fern and fireweed	-closed forests of Rocky Mountain Douglas-fir, western thimbleberry and oak fern
53		Lodgepole pine - Engelmann spruce - alpine fir subzone	-shrub-herb cover of black blueberry, oak fern and fireweed	-closed forests of Engelmann spruce, black blueberry and oak fern
54	Subalpine Engelmann spruce - alpine fir zone	Krummholz subzone	-herb dominated cover of grouseberry, mountain-heather, woolly pussytoes and alpine blue grass (133)	-

[1] One sequence is shown for each subzone. These sequences are for average or mesic sites.

[2] Numbers in parentheses refer to vegetation types in which information on species and vegetative cover can be obtained from vegetation type descriptions in Volume Three.

[3] For a description of each soil association component see Lacelle (in preparation).

Overmature Seral	Climax	Comments	Major Soil Association Components[2]
-broad-leaved forests of black cottonwood, western red-osier dogwood and sweet-scented bedstraw	-broad-leaved forest of black cottonwood with a dense shrub layer of western red-osier dogwood and sweet-scented bedstraw	-calcareous soils; highly variable water table; generally a dense shrub layer and sparse herb layer; severe disturbance creates a cover dominated by willow and yellow mountain-avens	FU_{10}, FU_{11}, FV_{10}, FV_{11}
-mixed forests of black cottonwood, Engelmann spruce, western red-osier dogwood and wild rye grass	-mixed forests of Engelmann spruce, black cottonwood, western red-osier dogwood and wild rye grass	-moderately high water table and good surface drainage allows a mixture of spruce and cottonwood to form the climax	FU_3, FV_1
-mixed forests of Engelmann spruce, black cottonwood, common horsetail, palmate colt's-foot and moss	-closed forests of Engelmann spruce with an understory of black swamp gooseberry and a continuous cover of common horsetail (112, 33)	-high water table; poor drainage and poor soil aeration at the surface; spruce regeneration may be restricted by water table	FE_1, FU_1, FV_1, FV_2
-mixed forests of Engelmann spruce, trembling aspen, common snowberry and Canadian bunchberry	-closed forests of Engelmann spruce with a dense shrub layer of common snowberry with Canadian bunchberry and mosses (75, 76)	-relatively deep water table; soils are neutral to slightly acidic; frequently associated with finer-textured soils	CLD_1, CW_1, FO_4, GB_1, KG_1, LL_1, LN_1, MC_1, MM_1, MX_1, SP_1

Maturing Seral	Overmature Seral	Climax	Comments	Major Soil Association Components[3]
-closed forests of lodgepole pine, western hemlock, Oregon boxwood and northern twinflower (44)	-closed forests of western hemlock, Oregon boxwood, northern twinflower and mosses	-closed forests of western hemlock and western red cedar with an understory of Oregon boxwood, northern twinflower and mosses	-areas of relatively high precipitation for the study area; somewhat leached soils; fair amount of organic litter accumulation; forests tend to get quite dense in later stages which limits understory density	AS_1, BN_5, CE_1, FR_1, GY_1, KR_1, LY_1, SY_1
-closed forests of alpine fir, western hemlock, black blueberry, oak fern and mosses	-closed forests of western hemlock, alpine fir, black blueberry, oak fern and mosses (37)	-closed forests of western hemlock and western red cedar with an understory of black blueberry, oak fern and mosses	-higher precipitaton than other subzone; leached, fairly acidic soils; forests tend to get quite dense in later stages which limits understory density	BH_5, BK_5, CL_1, CP_1, KA_1, SL_1, SS_1
-closed forests of Rocky Mountain Douglas-fir, western red cedar, western thimbleberry, oak fern and mosses (69)	-closed forests of western red cedar, Rocky Mountain Douglas-fir, oak fern and mosses (68)	-closed forests of western red cedar with a sparse understory of shrubs and herbs, and mosses (68)	-in later stages the tree cover may get very dense which inhibits understory growth; relatively high precipitation for the study area; generally calcareous soils	AZ_1, BF_5, CAI_1, CLD_1, CR_1, FL_1, KE_1, MU_1, MY_1, RS_5
-closed forests of Engelmann spruce, western red cedar, black blueberry, oak fern and mosses	-closed forests of western red cedar, Engelmann spruce, black blueberry, oak fern and mosses	-closed forests of western red cedar with a sparse understory of black blueberry and mosses	-in later stages the tree cover may get very dense which inhibits understory growth; higher precipitation than other subzone; calcareous to mildly acidic soils	BS_5, CW_1, GB_1, LN_1 MM_1, SP_1
-	-	-stunted tree islands of alpine fir with an understory of mountain-heather and grouseberry (134)	-severe climate, short growing season; intermediate stages between disturbance and climax have a gradual establishment of alpine fir; tree establishment is slow	COY_7, COY_8, MP_5, MP_8, RA_7, RA_8

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APPENDIX A

GLOSSARY[1]

ALPINE TUNDRA
A treeless area dominated by cold-tolerant vegetation often consisting of low shrubs and herbs that require a short period of time to complete their life cycle.
Formal Definition Source: Terrestrial Studies Branch (in preparation).

BEDROCK
Exposed rock which is generally unvegetated and rock, covered by less than 10 cm of loose materials which is generally sparsely vegetated.
Formal Definition Source: E.L.U.C. Secretariat (1976).

BIOPHYSICAL LAND CLASSIFICATION
A holistic classification of the landscape aiming to delineate ecologically significant segments of the landscape (Lacate, 1969). These land units are differentiated on the basis of geology, terrain, climate, forest zone, soil development and vegetative community. The classification may be used as a basis for interpretations respecting (i) land capability for agriculture, forestry, wildlife and outdoor recreation, and (ii) land suitability for urban, industrial and transportation development.
Formal Definition Source: Walmsley and van Barneveld (1977).

BIOPHYSICAL TYPE
The most detailed category of the biophysical land classification characterized by landscape segments that are uniform with regard to soils and potential for certain vegetation community types.
Formal Definition Source: van Barneveld (1976).

BOG
Areas of organic substrate covered by ombrotrophic (mineral-poor, rain-fed) mosses (usually sphagnum), with or without trees.

BROAD-LEAVED FOREST
Dominated by broad-leaved tree species with less than ten percent of the total cover comprised of coniferous trees.
Formal Definition Source: Terrestrial Studies Branch (in preparation).

BROWSE SPECIES
Woody plants (shrubs and trees) which provide food for wildlife and cattle.

BRUNISOL (BRUNISOLIC SOIL)
An order of soils generally formed under forest stands. The soils vary from acidic to basic, have a weakly developed enriched layer that is commonly brown coloured, and lacks a clay enriched layer.
Formal Definition Source: Agriculture Canada (1978).

CHERNOZEM (CHERNOZEMIC SOIL)
An order of soils having surface horizons darkened by the accumulation of organic matter derived from the decomposition of grasses and herbs representative of the dry grasslands and grassland-forest transition.
Formal Definition Source: Agriculture Canada (1978).

CLIMATIC CLIMAX
See Climax Vegetation

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[1] Definitions are intended for lay readers. Formal definitions may be obtained by referring to the Formal Definition Source.

CLIMAX VEGETATION

Plant communities that have developed to an equilibrium with their environment and are self-perpetuating are referred to as climax vegetation. Plant species found in these climax stands are climax species. In climax stands those tree species regenerating are the same as those in the tree canopy.

a) Climatic climax vegetation - this is the climax community found on medium-textured well-drained soils. Vegetation generally reflects the climate of an area. Young climatic climax vegetation is generally less than sixty years old; maturing climatic climax vegetation has acquired the structure and composition of mature stands. They are generally more than sixty years old.

b) Edaphic climax vegetation - this is the climax vegetation which more directly reflect site conditions such as extreme soil characteristics or a topographic position which causes the climax plant communities to differ from the climatic climax. Young edaphic climaxes are generally less than sixty years; maturing edaphic climaxes are usually more than sixty years old.

Formal Definition Source: Ministry of Environment and Ministry of Forests (1980)

COLLUVIAL MATERIALS (COLLUVIUM)

Surface materials which have reached their present position through downslope, gravity-induced movement.

Formal Definition Source: E.L.U.C. Secretariat (1976).

CONIFEROUS FOREST

Dominated by coniferous tree species with less than ten percent of its cover comprised of broad-leaved trees.

Formal Definition Source: Terrestrial Studies Branch (in preparation).

DENSE FOREST

Greater than fifty percent crown cover of trees.

Formal Definition Source: Terrestrial Studies Branch (in preparation).

DISSIMILARITY ANALYSIS

An analysis method used to develop vegetation types for the East Kootenay which divides sets of vegetation plots into two subsets maximizing the difference between the subsets. This method was used to aid in the development of Vegetation Types for the East Kootenay study.

Formal Definition Source: McNaughton-Smith (1965).

DRAINAGE

The speed and extent of water removal from soils in relation to water additions. The following classes are recognized: rapidly drained, well drained, moderately well drained, imperfectly drained, poorly drained, very poorly drained.

Formal Definition Source: Agriculture Canada (1978).

ECOLOGY

The study of the relationship between organisms and their environment. In this study the term more specifically refers to the relationship between plants, soils and climate, in nutrient cycling and energy capturing.

EDAPHIC

Resulting from, or influenced by, factors inherent in the soil or other substrate rather than by climatic factors. In this study edaphic refers to atypical soil conditions which results in different vegetation than occurs on typical soils.

EDAPHIC CLIMAX

See Climax Vegetation

EOLIAN MATERIALS

Materials that have been transported by wind action.

Formal Definition Source: E.L.U.C. Secretariat (1976).

EVAPOTRANSPIRATION

The loss of water from a given area by evaporation from the soil surface and by transpiration from plants.

FEN
Areas with organic substrate in which the plants are rooted, covered by minerotrophic (mineral-rich, groundwater-fed) sedges. The water table reaches up to the surface for part of the year, enriching the organic materials with nutrients.

FLOODPLAIN
The land bordering a stream (or river) built up of sediments from overflow and subject to inundation when the stream is at flood stage.
Formal Definition Source: E.L.U.C. Secretariat (1976).

FLUVIAL MATERIALS
Materials transported and deposited by streams and rivers. This includes Fluvioglacial Deposits which are materials that show clear evidence of having been deposited either directly in front of, or in contact with glacier ice.
Formal Definition Source: E.L.U.C. Secretariat (1976).

FORBS
All herbs excluding grasses, sedges and rushes.

FOREST REGION
The area subjected to a characteristic regional climate over which the vertical sequences of forest zones is similar and includes a zone characteristic of the regional climate.
Formal Definition Source: Terrestrial Studies Branch (in preparation).

FOREST SECTION
An area, within a Forest Region, defined by a specific pattern of forest zones and/or subzones. Forest Sections may also be distinguished for areas of differing regional climates as evident from the climax vegetation of comparable edaphic sites.
Formal Definition Source: Terrestrial Studies Branch (in preparation).

FOREST SUBZONE
An area within a forest zone defined on the basis of climate-related successional trends of the dominant vegetation on representative sites or climate related differences in growth form of the dominant vegetation.
Formal Definition Source: Terrestrial Studies Branch (in preparation).

FOREST ZONATION
One or more classes of the vegetation classification of Forest Regions, Sections, Zones and Subzones. Forest Zonation is based on the distribution of dominant climax and seral species in relation to climatic conditions.
Formal Definition Source: van Barneveld (1976).

FOREST ZONE
An area of the landscape in which, on sites of similar soil and topographic conditions, the dominant (actual or potential) vegetation of the climax stands is identical. Zones are usually characterized by the climatic climax vegetation.
Formal Definition Source: Terrestrial Studies Branch (in preparation).

GENUS (pl. GENERA)
A group of closely related species that usually cannot interbreed. The species of a genus generally have similar form and functional features but they often have different habitat requirements.

GLEYSOLS (GLEYSOLIC SOILS)
An order of soils developed under permanent or periodic wet, reducing condition. They commonly are associated with a high groundwater table some time of the year or have temporary saturation above an impermeable layer.
Formal Definition Source: Agriculture Canada (1978).

HERBAGE
Herbaceous plants and grasses which provide forage for wildlife and domestic stock.

HERB LAYER
The structural layer in a vegetation stand composed of all herbaceous plants and dwarf shrubs growing on the dominant substrate.
Formal Definition Source: Ministry of Environment and Ministry of Forests (1980).

KRUMMHOLZ
In response to severe and fluctuating climatic conditions, subalpine tree species occur in stunted and layered forms as scattered individuals, in clumps (tree islands), or in discontinuous coverage with the treeless areas dominated by herbs, lichens, and/or shrubs.
Formal Definition Source: Terrestrial Studies Branch (in preparation).

LACUSTRINE MATERIALS (including GLACIOLACUSTRINE)
Sediments that have settled from suspension in bodies of standing fresh water, including glacial lakes, or that have accumulated at their margins through wave action. The sediments commonly consist of fine sand, silt and clay deposits.
Formal Definition Source: E.L.U.C. Secretariat (1976).

LOW SHRUB LAYER
All shrubs and tree regeneration less than two metres in height, except specific dwarf shrubs (low ground cover).

LUVISOL (LUVISOLIC SOIL)
Soils commonly having a loose, gray coloured, eluviated (leached) layer and a firmer clay enriched horizon. They commonly develop under moderately dry forests in medium to fine textured parent materials.
Formal Definition Source: Agriculture Canada (1978).

MEADOW
Treeless area dominated by herbaceous plants in response to moist soil conditions from snowmelt, seepage and/or high water tables for at least part of the year.
Formal Definition Source: Terrestrial Studies Branch (in preparation).

MIXED FOREST
A mixture of coniferous and broad-leaved trees in which the cover of both is greater than ten percent of the crown cover present.
Formal Definition Source: Terrestrial Studies Branch (in preparation).

MOISTURE REGIME
The moisture regime of an area is a class of a relative scale of moisture available for plant growth that applies within the climatic regime of a forest subzone. From driest to wettest the classes are:
xeric
subxeric
submesic
mesic
subhygric
hygric
subhydric
hydric
Formal Definition Source: Ministry of Environment and Ministry of Forests (1980).

MORAINAL MATERIALS (MORAINE)
Material which has originated through transportation by glacial ice and which was deposited directly by the glacier without modification by water, wind or gravity.
Formal Definition Source: E.L.U.C. Secretariat (1976).

MOSS LAYER
The structural layer in a vegetation stand that contains all mosses, lichens and liverworts that grow on the dominant substrate.
Formal Definition Source: Ministry of Environment and Ministry of Forests (1980)

OPEN FOREST
A stand in which the tree crown coverage is between 25 and 50 percent. It often reflects poor regeneration or droughty soils.
Formal Definition Source: Terrestrial Studies Branch (1976).

ORGANIC DEPOSITS
Materials resulting from plant growth, decay and accumulation in wet areas where the rate of accumulation exceeds that of decomposition.
Formal Definition Source: E.L.U.C. Secretariat (1976).

PARENT MATERIAL (SURFICIAL MATERIAL)
The unaltered, or essentially unaltered, mineral or organic material in which a soil develops through the operation of soil-forming processes.
Formal Definition Source: E.L.U.C. Secretariat (1976).

PARKLAND FOREST
A stand for which the tree crown coverage is less than 25 percent. This vegetation is often a result of poor regeneration or droughty soil conditions.
Formal Definition Source: Terrestrial Studies Branch (in preparation).

PLANT COMMUNITY
Any relatively homogeneous assemblage of plants. It may be used at various levels of generalization. In this report no classification is implied.
Formal Definition Source: Daubenmire (1968).

PODZOL (PODZOLIC SOILS)
An order of soils with relatively highly leached horizons and fairly acidic conditions. The upper soil layers are generally red in colour. These soils are generally developed under forest or herb and shrub vegetation in moist, cool to cold climates.
Formal Definition Source: Agriculture Canada (1978).

REGOSOLS (REGOSOLIC SOILS)
An order of soils that lacks development of horizons due to youthfulness of the material, instability of the material such as mass wasting of slopes or to the nature of the material.
Formal Definition Source: Agriculture Canada (1978).

SAVANNAH
Areas virtually devoid of trees and dominated by drought-tolerant shrubs, with herbs and grasses forming the understory.
Formal Definition Source: Daubenmire (1968).

SEEPAGE
Any moisture that has been transmitted below the soil surface to supply additional free moisture to the rooting zone of plants and/or to become evident at the soil surface as free water.

SERAL VEGETATION
The continuously changing vegetation proceeding the stable climax vegetation is referred to as seral vegetation. Plant species that are not found in the climax stands are referred to as seral species. Four categories of seral vegetation are:
a) pioneer seral - disturbance has been severe enough to inhibit usual successional stages for a period of time, with a distinct vegetation 'pioneering' on the site.

b) young seral - usual successional stage generally younger than sixty years old.

c) maturing seral - usual successional stage generally between sixty and one hundred and forty years old. Both climax and seral species are usually present.

d) overmature seral - usual successional stage, generally older than one hundred and forty years old. Climax species may dominate or the overmature seral species are distinctly decadent as evident from dead tops and disease agents present.
Formal Definition Source: Ministry of Environment and Ministry of Forests (1980).

SHRUB LAYER
Structural layer of a vegetation stand that includes all shrubs (except dwarf shrubs) and tree regeneration under 10 m in height. It consists of low shrubs (less than 2 m) and tall shrubs (2 to 10 m). Species of the shrub layer are listed in Appendix F.
Formal Definition Source: Ministry of Environment and Ministry of Forests (1980).

SITE
An area of relatively homogeneous vegetation, soils, topography and climate.

SOIL

Soil is generally thought of as a loose (unconsolidated) material which occurs naturally on the earth's surface and which serves as a medium for the growth of land plants. Soil characteristics develop from weathering and translocation of weathering products and organic matter. The end product is a material which may differ significantly from the underlying parent material in many physical, chemical, mineralogical, biological and morphological properties.
Formal Definition Source: Agriculture Canada (1976).

SOIL ASSOCIATION

A group of soils that occur associated in the landscape based on similarities in climatic or physiographic factors, soil parent materials and vegetation zonation. Individual soil units within a soil association (components) are differentiated on the basis of relief, drainage, texture or other characteristics.
Formal Definition Source: Agriculture Canada (1978).

SOIL TEXTURE

The relative proportions of the various soil particle size components (clay, silt and sand) within soil materials (see Soil Texture Classes).

SOIL TEXTURE CLASSES

Soil texture may be grouped into classes at different levels. The generalized textural modifiers used within their corresponding divisions are:

coarse texture:	sand
	loamy sand
	sandy loam
medium texture:	loam
	silt loam
	silt
moderately fine texture:	silty clay loam
fine texture:	sandy clay loam
	clay loam
	sandy clay
	silty clay
	clay
	heavy clay

Formal Definition Source: Agriculture Canada (1978).

SPECIES

A population (of plants) made up of individuals that interbreed and share a common gene pool. Generally, these are individuals that have very similar form and functional features and have the same habitat requirements.

STAND APPEARANCE

The form and structure of the vegetative cover. Various categories are listed in Appendix D.

SUCCESSION

The progressive replacement of seral vegetation leading to climax vegetation.
Formal Definition Source: Daubenmire (1968); Ministry of Environment and Ministry of Forests (1980).

SUCCESSIONAL STAGE

A particular stage in the replacement sequence of seral vegetation. See Seral Vegetation and Climax Vegetation.

SURFICIAL DEPOSITS

Unconsolidated materials on the earth's surface. In Canada, the expression is usually applied to materials of the Quaternary age.
Formal Definition Source: E.L.U.C. Secretariat (1976).

TALL SHRUB LAYER

All shrubs and tree regeneration between two and ten metres high.
Formal Definition Source: Ministry of Environment and Ministry of Forests (1980).

TREE LAYER

Structural layer of a vegetation stand that includes tree species generally taller than 10 m. If the mature dominant tree canopy is less than 10 m, it is still regarded as the tree layer.
Formal Definition Source: Ministry of Environment and Ministry of Forests (1980).

UNGULATE

Hoofed animals which in the study area include cattle, white-tailed deer, mule deer, moose, elk, Rocky Mountain bighorn sheep, mountain goat and woodland caribou.

VEGETATION LANDSCAPE UNIT

The vegetation landscape units represent landscape areas that are relatively homogeneous with regard to soils, surficial materials, disturbance history, climate and macro vegetation. Each kind of unit represents ecological landscape segments that are relatively similar with regard to management alternatives, constraints to use and productivity for major crops. These units are mapped in association with forest zonation for the East Kootenay area by the Terrestrial Studies Branch.

Formal Definition Source: Terrestrial Studies Branch (in preparation).

VEGETATION TYPE

All plant communities similar with regard to floristic characteristics. It is derived from a classification of vegetation plots. 138 vegetation types have been described for the East Kootenay area. Description of these types are available in Volume Three of this report.

APPENDIX B

DATA, REPORT AND MAP AVAILAILITY

The following data, tables, reports and maps have not been included in this report but are available from the Terrestrial Studies Branch, British Columbia Ministry of Environment. Maps and reports are available on request from:

Map Library
Assessment and Planning Division
British Columbia Ministry of Environment
Parliament Buildings
Victoria, British Columbia
V8V 1X4, Canada
(604) 387-6995

Data is available on request from:

Head
Vegetation Unit
Terrestrial Studies Branch
British Columbia Ministry of Environment
Parliament Buildings
Victoria, British Columbia
V8V 1X4, Canada
(604) 387-1851

The following is available:

1. Vegetation Plot Data
   - Approximately 1 000 plots were described on standard Vegetation Data Forms (Vegetation Functional Subcommittee, 1976). Data includes floristic lists, physical data (including elevation, slope, aspect, topographic position, etc.), soils data and limited forest capability data.

2. Vegetation Types
   - Constancy tables (phytosociological) listing 200 species selected for analysis of plot data to define vegetation types, the percentage occurrence of each species in each type is listed.
   - Synthesis tables (phytosociological) which list the 200 species used for analysis of vegetation types; the percentage cover of each species in each plot is listed; the plots are grouped by vegetation types.
   - Physical Data Tables listing 13 physical characteristics for each plot. The plots are grouped by vegetation types.

3. Forest Zonation/Vegetation Landscape Unit Maps
   Maps cover the British Columbia portions of NTS 82G, 82J and 82 O, at a scale of 1:50 000. On these maps are the Forest Regions, Zones and Subzones that are described in Chapter Two of this volume. These units are further differentiated into Vegetation Landscape Units that are relatively homogeneous with regard to soils, surficial materials, disturbance history, climate and macro vegetation.

4. Springbrook Biophysical Project
   The Springbrook project was designed to provide basic information in map form to resolve resource conflicts between cattle grazing, wildlife use, recreation use and forestry activities. A multidisciplinary team produced maps at 1:50 000 for surficial geology, soils, wildlife, climate, agriculture capability, forestry capability, grazing capability, aquatic resources, forestry zonation and vegetation types. Economic analysis was attempted to depict the relative values of respective resource use allocations. The Springbrook Project Area extends from Canal Flats, south to Fort Steele, on the east side of the Kootenay River.

5. Resource Inventory and Interpretation for Urban Development and Transportation Requirements in the Southeast Kootenay Area (Walmsley, 1978) (report with map folio)
This report contains a description of the suitability for development of townsites and transportation corridors. Aspects that are evaluated include terrain, soils, climate, aquatic systems, outdoor recreation, visual resources, wildlife and vegetation.

6. Settlement Suitability Studies for Cranbrook and Windermere - Invermere areas (report and map folios)
These reports and maps are prepared to facilitate planning for further settlement development of these areas. Aspects evaluated include terrain, soils, climate, aquatic systems, groundwater, outdoor recreaction, visual resources, wildlife and vegetation.

APPENDIX C

SPECIES LIST

This is a list of the plant species mentioned in the report. The species are listed alphabetically by tree species, shrub species, herb and dwarf shrub species, and moss layer. The list covers the more common species of the East Kootenay area, as in this reconnaissance study, primarily sites representative of larger areas were sampled. Unique habitats may not have been sampled. Moss species generally were not considered unless they were dominant. Data was used from several surveys and was collected by various surveyors. For this reason certain species were complexed at the genus level, as identification of the species was not certain at the species level. Nomenclature follows Taylor and MacBryde (1977), except for mosses for which common names have been standardized within the Vegetation Unit, Terrestrial Studies Branch.

TREE SPECIES

Common Name	Botanical Name
alpine fir	Abies lasiocarpa
alpine larch	Larix lyallii
balsam poplar	Populus balsamifera subsp. balsamifera
black cottonwood	Populus balsamifera subsp. trichocarpa
common paper birch	Betula papyrifera
Engelmann spruce	Picea engelmannii
limber pine	Pinus flexilis
lodgepole pine	Pinus contorta
paper birch	Betula papyrifera
ponderosa pine	Pinus ponderosa
Rocky Mountain Douglas-fir	Pseudotsuga menziesii
spruce	Picea spp. (includes P. glauca x engelmannii)
trembling aspen	Populus tremuloides

TREE SPECIES (Cont'd)

Common Name	Botanical Name
western birch	Betula occidentalis
western hemlock	Tsuga heterophylla
western larch	Larix occidentalis
western red cedar	Thuja plicata
western white pine	Pinus monticola
white pine	Pinus monticola
white spruce	Picea glauca
whitebark pine	Pinus albicaulis

SHRUB SPECIES

alder-leaved buckthorn	Rhamnus alnifolius
American red raspberry	Rubus idaeus
antelopebush	Purshia tridentata
baldhip rose	Rosa gymnocarpa
big sagebrush	Artemisia tridentata
birch-leaved spirea	Spiraea betulifolia
black blueberry	Vaccinium membranaceum (includes V. globulare)
black swamp gooseberry	Ribes lacustre
blueberry	Vaccinium spp.
blue elder	Sambucus spp.
bristly Nootka rose	Rosa nutkana
choke cherry	Prunus virginiana
common juniper	Juniperus communis
common Labrador tea	Ledum groenlandicum
common rabbitbrush	Chrysothamnus nauseosus
common saskatoon	Amelanchier alnifolia
common snowberry	Symphoricarpos albus
creeping Oregon-grape	Mahonia repens (includes M. aquifolium)
currant	Ribes spp.
devil's-club	Oplopanax horridus
diamond willow	Salix glauca
glandular birch	Betula glandulosa
gooseberry	Ribes spp.

SHRUB SPECIES (Cont'd)

Common Name	Botanical Name
high bush cranberry	Viburnum edule
huckleberry	Vaccinium spp.
hoary willow	Salix candida
mallow ninebark	Physocarpus malvaceus
Oregon boxwood	Paxistima myrsinites
pin cherry	Prunus pensylvanica
prairie sagebrush	Artemisia frigida
prickly rose	Rosa acicularis
redstem ceanothus	Ceanothus sanguineus
Rocky Mountain juniper	Juniperus scopulorum
Rocky Mountain maple	Acer glabrum
roses	Rosa spp.
Scouler's willow	Salix scouleriana
shrubby cinquefoil	Potentilla fruticosa
Sitka mountain alder	Alnus viridis subsp. sinuata
Sitka mountain-ash	Sorbus sitchensis
snowberry	Symphoricarpos spp.
snowbush ceanothus	Ceanothus velutinus
smooth Pacific menziesia	Menziesia ferruginea
soopolallie	Shepherdia canadensis
tall Oregon-grape	Mahonia aquifolium
thin-leaved mountain alder	Alnus incana
twinberry honeysuckle	Lonicera involucrata
Utah honeysuckle	Lonicera utahensis
western birch	Betula occidentalis
western blue clematis	Clematis occidentalis
western red-osier dogwood	Cornus sericea
western snowberry	Symphoricarpus occidentalis
western thimbleberry	Rubus parviflorus
western yew	Taxus brevifolia

SHRUB SPECIES (Cont'd)

Common Name	Botanical Name
white-flowered rhododendron	Rhododendron albiflorum
willows	Salix spp. (generally S. scouleriana in forested habitats)
Woods' rose	Rosa woodsii

HERB AND DWARF SHRUB SPECIES (HERB LAYER)

alpine bistort	Bistorta vivipara
alpine blue grass	Poa alpina
alpine fescue	Festuca brachyphylla
alpine Indian paintbrush	Castilleja rhexifolia
alpine milk-vetch	Astragalus alpina
alpine timothy	Phleum alpinum
alpine willowherb	Epilobium anagallidifolium
American alpine smelowskia	Smelowskia calycina
American stinging nettle	Urtica dioica
American vetch	Vicia americana
arrow-leaved balsamroot	Balsamorhiza sagittata
arrow-leaved ragwort	Senecio triangularis
asters	Aster spp.
beardless bluebunch wheat grass	Agropyron inerme
beardtongue	Penstemon spp.
bear-grass	Xerophyllum tenax
Bellard's kobresia	Kobresia myosuroides
bent grass	Agrostis spp.
bitterroot lewisia	Lewisia rediviva
black alpine sedge	Carex nigricans
black-tipped ragwort	Senecio lugens
blue-bead clintonia	Clintonia uniflora
bluebunch wheat grass	Agropyron spicatum
blue grass	Poa spp.
blue-leaved cinquefoil	Potentilla diversifolia
bracted lousewort	Pedicularis bracteosa
broad-leaved arnica	Arnica latifolia
broad-leaved willowherb	Epilobium latifolium

HERB AND DWARF SHRUB SPECIES (HERB LAYER) (Cont'd)

Common Name	Botanical Name
brome grass	Bromus spp.
brown-eyed Susan	Gaillardia aristata
brown-haired orange-flowered arnica	Arnica fulgens
bulrushes	Scirpus spp.
Canadian bunchberry	Cornus canadensis
Canada violet	Viola canadensis
cattail	Typha latifolia
chickweed	Cerastium spp.
clovers	Trifolium spp.
Columbia bladderpod	Lesquerella douglasii
Columbia brome grass	Bromus vulgaris
Columbia gromwell	Lithospermum ruderale
Columbia lily	Lilium columbianum
common cattail	Typha latifolia
common cow-parsnip	Heracleum sphondylium
common dandelion	Taraxacum officinale
common harebell	Campanula rotundifolia
common horsetail	Equisetum arvense
common lady fern	Athyrium filix-femina
common mitrewort	Mitella nuda
common pearly everlasting	Anaphalis margaritacea
common pink pyrola	Pyrola asarifolia
common silverweed	Potentilla anserina
common timothy	Phleum pratensis
common western pipsissewa	Chimaphila umbellata
cream-coloured peavine	Lathyrus ochroleucus
cream mountain-heather	Phyllodoce glanduliflora
creek goldenrod	Solidago canadensis
creeping sibbaldia	Sibbaldia procumbens
cucumberroot twistedstalk	Streptopus amplexifolius
Cusick's speedwell	Veronica cusickii
death-camas	Zigadenus venenosus
delphiniums	Delphinium spp.
desert parsley	Lomatium ambiguum
Douglas' aster	Aster subspicatus

HERB AND DWARF SHRUB SPECIES (HERB LAYER) (Cont'd)

Common Name	Botanical Name
drooping brome grass	Bromus tectorum
Drummond's rush	Juncus drummondii
dusky brown pussytoes	Antennaria umbrinella
dwarf blueberry	Vaccinium caespitosum
dwarf red blackberry	Rubus pubescens
dwarf scouring-rush	Equisetum scirpoides
dwarf spike-rush	Eleocharis parvula
early blue violet	Viola adunca
elegant death-camas	Zigadenus elegans
evergreen yellow violet	Viola orbiculata
fairyslipper	Calypso bulbosa
false bughane	Trautvetteria caroliniensis
false Solomon's-seal	Smilacina racemosa
fescues	Festuca spp.
few-flowered one-sided wintergreen	Orthilia secunda
few-flowered shooting star	Dodecatheon pulchellum
field chickweed	Cerastium arvense
field locoweed	Oxytropis campestris
field mint	Mentha arvensis
field pussytoes	Antennaria neglecta
fireweed	Epilobium angustifolium
five-leaved creeping raspberry	Rubus pedatus
fleabanes	Erigeron spp.
goldenweeds	Haplopappus spp.
graceful cinquefoil	Potentilla gracilis
green false hellebore	Veratrum viride
green pyrola	Pyrola chlorantha
grouseberry	Vaccinium scoparium (includes V. myrtillus)
hair grasses	Deschampsia spp.
hairy arnica	Arnica mollis
hairy golden-aster	Heterotheca villosa
hawkweed	Hieracium spp. (generally H. albiflorum)
heart-leaved arnica	Arnica cordifolia
heart-leaved twayblade	Listera cordata
Holboell's rock cress	Arabis holboellii

HERB AND DWARF SHRUB SPECIES (HERB LAYER) (Cont'd)

Common Name	Botanical Name
hooded ladies-tresses	Spiranthes romanzoffiana
Hooker's fairybells	Disporum hookeri
horsetails	Equisetum spp.
Idaho fescue	Festuca idahoensis
Indian paintbrush	Castilleja spp. (generally C. miniata; may include C. occidentalis and C. rhexifolia at high elevations)
inland blue grass	Poa interior
Kentucky blue grass	Poa pratensis
kinnikinnick	Arctostaphylos uva-ursi
lance-leaved stonecrop	Sedum lanceolatum
large-leaved rattlesnake orchid	Goodyera oblongifolia
locoweeds	Oxytropis spp.
low bilberry	Vaccinium myrtillus
low pussytoes	Antennaria dimorpha
lupines	Lupinus spp. (generally L. sericeus in low elevation habitats)
Lyall's goldenweed	Haplopappus lyallii
Lyall's phacelia	Phacelia lyallii
Merten's cassiope	Cassiope mertensiana
moss campion	Silene acaulis
mountain forget-me-not	Myosotis asiatica
mountain-heathers	Phyllodoce spp.
mountain sweetcicely	Osmorhiza chilensis
mountain valhodea	Valhodea atropurpurea
narrow-leaved lomatium	Lomatium triternatum
narrow-leaved stephanomeria	Stephanomeria tenuifolia
needle grasses	Stipa spp.
needle-and-thread grass	Stipa comata
nodding onion	Allium cernuum
northern bedstraw	Galium boreale
northern gentian	Gentianella amarella
northern goldenrod	Solidago multiradiata

HERB AND DWARF SHRUB SPECIES (HERB LAYER) (Cont'd)

Common Name	Botanical Name
northern hedysarum	Hedysarum boreale
northern red-fruited comandra	Geocaulon lividum
northern small reed grass	Calamagrostis inexpansa
northern twinflower	Linnaea borealis
northwestern sedge	Carex concinnoides
Nuttall's pussytoes	Antennaria parvifolia
oak fern	Gymnocarpium dryopteris
old man's whiskers	Geum triflorum
one-flowered cinquefoil	Potentilla uniflora
one-flowered wintergreen	Moneses uniflora
Pacific anemone	Anemone multifida
palmate colt's-foot	Petasites palmatus
parsnip-flowered umbrellaplant	Eriogonum heracleoides
penstemon	Penstemon spp.
pine grass	Calamagrostis rubescens
pink microsteris	Microsteris gracilis
poverty oat grass	Danthonia spicata
prairie crocus	Pulsatilla patens
prairie koeleria	Koeleria macrantha
prairie sagebrush	Artemisia frigida
pussytoes	Antennaria spp.
quack grass	Agropyron repens
racemose pussytoes	Antennaria racemosa
ragworts	Senecio spp.
red baneberry	Actaea rubra
red mountain-heather	Phyllodoce empetriformis
Richardson's crane's-bill	Geranium richardsonii
Richardson's needle grass	Stipa richardsonii
Rocky Mountain ragwort	Senecio streptanthifolius
rosy pussytoes	Antennaria microphylla
rough fescue	Festuca scabrella
rough-fruited fairybells	Disporum trachycarpum
rough-leaved rice grass	Oryzopsis asperifolia

HERB AND DWARF SHRUB SPECIES (HERB LAYER) (Cont'd)

Common Name	Botanical Name
round-leaved alumroot	Heuchera cylindrica
rushes	Juncus spp.
Sandberg's blue grass	Poa sandbergii
scouring-rush	Equisetum spp.
sedges	Carex spp.
selaginellas	Selaginella spp.
shaggy fleabane	Erigeron pumilis
short-beaked false dandelion	Agoseris glauca
showy aster	Aster conspicuus
sickle-top lousewort	Pedicularis racemosa
silky lupine	Lupinus sericeus
Sitka valerian	Valeriana sitchensis
slender hawk's-beard	Crepis atrabarba
slender wheat grass	Agropyron pauciflorum
small-flowered blue-eyed Mary	Collinsia parviflora
small-flowered bulrush	Scirpus microcarpus
small western needle grass	Stipa occidentalis
smooth aster	Aster laevis
spike-like goldenrod	Solidago spathulata
spike trisetum	Trisetum spicatum
spiny shield fern	Dryopteris assimilis
spreading dogbane	Apocynum androsaemifolium
spreading phlox	Phlox diffusa
star-flowered false Solomon's-seal	Smilacina stellata
stiff club-moss	Lycopodium annotinum
subalpine buttercup	Ranunculus eschscholtzii
subalpine fleabane	Erigeron peregrinus
sulphur hedysarum	Hedysarum sulphurescens
sweet-scented bedstraw	Galium triflorum
thistles	Cirsium spp.
thread-leaved sandwort	Arenaria capillaris
three-spot mariposa lily	Calochortus apiculatis
timber milk-vetch	Astragalus miser
tufted phlox	Phlox caespitosa
umbrellaplant	Eriogonum spp.
unifoliate-leaved foamflower	Tiarella unifoliata

HERB AND DWARF SHRUB SPECIES (HERB LAYER) (Cont'd)

Common Name	Botanical Name
violets	Viola spp.
western Indian paintbrush	Castilleja occidentalis
western meadow-rue	Thalictrum occidentale
western mountainbells	Stenanthium occidentale
western needle grass	Stipa occidentalis
western pasqueflower	Pulsatilla occidentalis
western spring beauty	Claytonia lanceolata
western white clematis	Clematis ligusticifolia
western yarrow	Achillea millefolium
wheat grasses	Agropyron spp.
white hawkweed	Hieracium albiflorum
white mountain-avens	Dryas octopetala
wild chive	Allium schoenoprasum
wild flax	Linium perenne
wild rye grasses	Elymus spp.
wild sarsaparilla	Aralia nudicaulis
wild strawberry	Fragaria virginiana
wood-rushes	Luzula spp.
wood strawberry	Fragaria vesca
woolly plantain	Plantago patagonica
woolly pussytoes	Antennaria lanata
yellow columbine	Aquilegia flavescens
yellow glacier lily	Erythronium grandiflorum
yellow mountain-avens	Dryas drummondii
yellow penstemon	Penstemon confertus
yellow salsify	Tragopogon dubius
yellow wood violet	Viola glabella

MOSS LAYER (MOSS, LICHENS AND LIVERWORTS)

brachythecium mosses	Brachythecium spp.
common moss	Pleurozium schreberi
cushion mosses	Dicranum spp.

MOSS LAYER (MOSS, LICHENS AND LIVERWORTS) (Cont'd)

Common Name	Botanical Name
feather moss	Ptilium crista-castrensis
fruticose lichens	Cladonia spp.
hairy-cap moss	Polytrichum spp.
layered moss	Hylocomium splendens
mnium mosses	Mnium spp.
sheet lichens	Peltigera spp.
small cushion moss	Dicranum fuscescens
sphagnum moss	Sphagnum spp.

MAPS NOT

FILMED

CARTES

OMISES

POOR

QUALITY

ORIGINAL